Vol. XXX, No. 8 *Whole No. 262*

NOVEMBER, 1930

SCHOOL SCIENCE AND MATHEMATICS

FOUNDED BY C. E. LINEBARGER

A Journal for all SCIENCE AND MATHEMATICS TEACHERS

CONTENTS:

Published by THE CENTRAL ASSOCIATION OF SCIENCE AND MATHEMATICS TEACHERS
Publication Office: 404 N. WESLEY AVE., MOUNT MORRIS, ILLINOIS
Business Office: 1439 FOURTEENTH ST., MILWAUKEE, WISCONSIN
Editorial Office: 7633 CALUMET AVE., CHICAGO, ILLINOIS

Published monthly, October to June, Inclusive, at Mount Morris, Illinois *Price, $2.50 Per Year: 35 Cents Per Copy*
Entered as second-class matter March 1, 1913, at the Post Office at Mount Morris, Illinois, under the Act of March 3, 1879

Now Ready

Turtox Biology Catalog and Teachers Manual

1930-31 Edition

Written primarily for the high school teacher but also of interest to teachers in normal schools, colleges and universities. The new book contains 300 pages, over half of which are devoted to a teachers' manual and to chapters on laboratory and field work.

Free to Biology teachers and educational officials.

Ask For Your Copy

TURTOX PRODUCTS

The Sign of the Turtox Pledges Absolute Satisfaction

General Biological Supply House
(Incorporated)

761-763 East 69th Place

CHICAGO ILLINOIS

PROBLEMS IN GENERAL SCIENCE

By

HUNTER & WHITMAN

EACH UNIT begins with introductory questions and an interesting preview and is followed by self-testing exercises, achievement tests, fundamental concept tests, projects, practical problems, etc.

AMERICAN BOOK COMPANY

330 E. 22d Street, Chicago, Illinois

New York Cincinnati Chicago Boston Atlanta

Every man has three characters—that which he exhibits, that which he has, and that which he thinks he has.—Karr.

CONTENTS *for* NOVEMBER, 1930

No Numbers Published for
JULY, AUGUST AND SEPTEMBER
Contents of previous issues may be found in the Educational Index to Periodicals.

School Science and Mathematics

A Journal for All Science and Mathematics Teachers

Published Monthly except July, August and September,
at 404 N. Wesley Ave., Mount Morris, Ill.

PRICE. The subscription price is Two Dollars and Fifty Cents a year; Canada $2.75; foreign countries $3.00; single copies 35 cents.

ALL REMITTANCES should be made payable to the order of **School Science and Mathematics and mailed to the Business Manager. Remittances should be made by Post Office Money Order, Express Order, or Bank Draft.** If personal checks are sent, please add five cents for collection.

CHANGE OF ADDRESS. Subscribers should send notice of any change of address to the Business Manager before the 12th of each month; otherwise they are held responsible for magazine sent to their former address, and no duplicate copies will be sent except on payment of 35 cents for each copy.

MISSING NUMBERS will be replaced *free* only when claim is made within thirty days after receipt of the number following.

BACK NUMBERS can be obtained from the Business Manager at 40c (or more) per issue depending on the date of issue and the supply. Write for quotation.

REPRINTS, if desired, must be ordered in advance of publication. Reprints of leading articles will be printed as ordered, the actual cost (with cover, if desired) to be paid for by the author.

MANUSCRIPTS. Contributions on Science and Mathematics Teaching are invited. Articles must be written on one side of the sheet only. All illustrations must be drawn or written in jet black on a separate sheet of manuscript. Contributors are requested to write scientific and proper names with particular care. Manuscripts should be sent to the Editor of **School Science and Mathematics, 7633 Calumet Ave., Chicago,** or to the proper departmental Editor. Books and pamphlets for review should be sent to the Editor.

Entered as Second-Class Matter March 1, 1913, at the Post Office at Mount Morris, Illinois, under the Act of March 3, 1879

SCHOOL SCIENCE AND MATHEMATICS

VOL. XXX No. 8 NOVEMBER, 1930 WHOLE No. 262

TRAINING IN SERVICE

After a young man (or woman) has completed the regular college course, has taken the essential and required professional work and has done his turn at practice teaching, it is frequently assumed that he is a teacher providing he can land a position. It should be emphasized by salary scale, responsibility in position, and provision for supervision that he is now ready to enter the profession but that it will take a period of about ten years for him to acquire the necessary skill in presentation, to establish habits of self-control, to master the details of his subject, and to become an adept in teaching. By this time he has either discovered that he is in the wrong pew and has dropped out of the profession, or he has made a fair start and then neglected his professional growth for various sidelines and is rapidly becoming dead timber, or he has kept growing and has become a skilled member of the profession.

One of the essential virtues for continuous professional growth is an abiding interest in the subject taught. Since no teacher has time to work out all the interesting sidelights connected with his subject and many are so situated that they do not have facilities for extensive reading, it is valuable to exchange the results of reading courses. To meet this condition SCHOOL SCIENCE AND MATHEMATICS publishes many articles on restricted topics in subject matter which contain nothing new but which have been collected from various sources and put in form to be easily assimilated and made immediately

available for classroom use. A contributor of such an article should choose a topic so limited that the useful sidelights and applications can be clearly treated in a few pages. References showing the sources from which the ideas have been obtained should be included in the form of a bibliography. A contribution of this kind is especially valuable if it deals with the newer developments of a subject where the source material is gleaned from current literature or lectures, but a classical topic may be made the basis for such work.

CALL FOR CONTRIBUTIONS TO THE KEPLER FUND.

(Dated Weilderstadt, July, 1930)

By G. W. Myers.

The thought that some of our readers may care to interest themselves in a worthy scientific movement, the announcement of which has been recently sent abroad throughout the scientific world with the backing of the leading scientists and scholars of Germany, has led us to publish this call for help in our pages.

"On November 15, 1930, it will have been 300 years since the great astronomer, John Kepler, departed this life. On this day the whole world will call to remembrance the great scholar and, as in other places of the empire so also in Weilderstadt, the natal town of Kepler, there will be held during the course of the year, a Kepler commemorative celebration.

"But such a celebration does not yet repay all that we owe to this noble man. It is proposed also to erect to him who has contributed so much to the renown of Germany throughout the world, an enduring memorial to his own fame and worth. The little house in Weilderstadt in which he was born, is to be purchased and fitted out as a modest museum in which all the existing mementos, pictures, writings and works of Kepler, some of them stored heretofore in the city hall and some to be yet procured, may find a fitting home and adequate care.

"Just as to Schiller, poet of idealism and freedom, there has been established as a memorial in Marbach a museum in the house of his activity so also is there to be erected in the house of Kepler's birth now after three centuries, a worthy memorial to the other great Swabian, the discoverer of the laws of planetary motion.

"Besides this also the Kepler monument in the market place of Weilderstadt, which was erected in the year 1870 by the entire cultured world, and whose sandstone pediment during the course of years has suffered considerable deterioration, is soon to be renovated. The scant 2,000 inhabitants of Weilderstadt have not the financial ability to raise among themselves the funds needed for these undertakings. It therefore devolves on all who honor Kepler and the lofty spirit in which he lived, worked and suffered and who strive to keep such spirit awake, to comply with the earnest request for a contribution to a Kepler fund, whence the proposed plans may be realized.

It would be a special and happy outcome of this undertaking if contributions would flow in so generously that Kepler's natal village of Weilderstadt might be put in position to honor themselves by thus contributing to the institutions destined to foster and enhance the scientific heritage of this great son of the ancient imperial town."

Contributions may be sent direct to Account 405, Vorschussbank of Weilderstadt, Germany, postal check Stuttgart 4365.

SOME QUESTIONS.

1. Do the pupils in your school like mathematics?
2. What per cent of the students enroll in elective courses in mathematics?
3. Are elective courses in mathematics increasing or decreasing in popularity?
4. Can your high school seniors perform the ordinary processes of arithmetic accurately and rapidly? Can they solve simple equations in algebra? How about quadratics?
5. Is science increasing or decreasing in popularity?
6. Is the answer the same for all science?
7. Do students elect or shun the science courses?
8. Can physical science be made popular by eliminating mathematics from these courses? Should it be done?
9. How does administration of the curriculum affect the enrollment in science? Do students elect history rather than science because science requires seven hours per week while history requires only five for the same credit?
10. Would the courses in physics, chemistry and biology be more, or less popular if the individual laboratory work were eliminated?

It is not safe to merely guess at the answers to these questions. Collect the data. These may be disturbing but the process and its results will contribute to progress in your school. Interesting figures and pertinent suggestions relative to some of these questions are given in this issue by Mr. A. C. Monahan. Other articles relevant to this topic will appear in future issues. If you have any evidence, send it in. If you have discovered the remedy for any of the chronic educational ills in this field, pass the good news along.

REMARKS ON THE HISTORY OF COSMIC RADIATION.*

By Robert A. Millikan.

Explanatory Note.

The hypothesis that atoms are generated in the depths of interstellar space by the condensation of radiant energy and that the origin of the stellar energies is to be found in the dissolution of the atoms within the stars was an hypothesis put forward by MacMillan in 1915 and has been under discussion since that time at the Ryerson Laboratory. It had become fairly obvious from the evidences of geology, the dynamics of the solar system, and particularly the dynamics of galaxis that the classical hypothesis of Helmholtz that the origin of the sun's heat was due to the contraction of the sun was altogether inadequate, and a new hypothesis was required. That a relation between mass and energy existed was suggested to Professor MacMillan by the evidences of astronomy. His hypothesis is in harmony with the electron theory of the physicists and it has found direct support from the recent studies of the cosmic radiation by Millikan. It forms a suitable background for the planetesimal hypothesis of Chamberlin and Moulton; and the two hypotheses taken together give us a cosmological picture which is attractive philosophically and in accord with our knowledge of astronomy and physics.—H. E. Slaught.

In previous articles I have never sought to assign the origin or history of the speculative ideas about atom building in cosmic processes—a very ticklish thing to do, since during the past twenty years this question has aroused general interest. But if the historian of this domain can find anything useful in it, I will be glad to contribute my own knowledge of the history of the subject.

In the year 1904, when I was engaged in the study of certain rare ores for their uranium content by the action of radioactivity, Professor F. R. Moulton of the University of Chicago came to me with the statement that even if the sun were originally of pure uranium it could not have given up as much energy as he would regard as necessary for a minimum of the life of the sun, and that therefore it was necessary to postulate a store of cosmic energy from a previously unknown source for the stellar energies.

Now this source had already been found, although I did not, at that time, fully appreciate it; the interchangeability of mass and energy was demonstrated in the year 1901 for special cases by the experiments of Kaufmann, and the discovery of radiation pressure some years before was also of great importance. A few years later (1905) Einstein discovered this interchangeability as a consequence of the special relativity theory, and from this time

*Translated from the Physicalische Zeitschrift, Nr. 6, March, 1930.

on this theory was available to any one, who, like Professor Moulton, was seeking a new source of energy for the continued existence of the life of the celestial bodies. Certainly, for something less than ten years it was a theme of general table conversation at the University of Chicago. As soon as the Mosleyian relations (1913-14) and the existence of the isotopes were discovered, atom building within the stars, accompanied by a change of the superfluous mass into radiation was considered as a source of stellar energy. Harkins (Phil. Mag. 30, 723; 1915) explained in detail this loss of mass, or "packing effect" in the atom building process. I mentioned this fact in the first edition of my book "The Electron" (1917) page 203.

That this phenomenon is not sufficient to explain the energy of the universe was shown later on. In *Nature* (1917) Eddington mentioned the idea of the annihilation of matter by collision and the complete superposition of the positive and negative electrical fields, and ascribed the idea to Jeans *(Nature, 70, 101; 1904)*.

Certainly by the year 1915 the idea of the building of the elements from hydrogen as a source of universal energy was prevalent, and in 1917 the total destruction of mass as a more active source found its way definitely into the literature, and were familiar at other universities than Chicago; since these ideas are obvious consequences of the Einstein equations (1905) and the known existence of isotopes (hydrogen with the atomic weight 1.008 instead of 1.)

In our conversations at Chicago W. D. MacMillan constantly held out for the view that a still further step forward should be taken and that the idea of the 'running down of the universe' should be given up by the assumption that atom building went on in space by the condensation of radiation into atoms. He discussed this idea with me in detail in the year 1915, and in July 1918 he published it in full (Astrophysical Jour. 48, 35; 1918). Any one who is interested in the history of this subject should read MacMillan's other articles (Science, 62, July 24th and Aug. 7, 1925), since this investigator, on the theoretical side, is the foremost representative of the idea of the

development of cosmic energy by the process of atom building.

These three ideas, first atom building from hydrogen, second, the radiating away of mass, and third, the condensation of radiant energy into atoms, are the hypotheses for which we have obtained partial experimental proof.

Heretofore I have not tried to assign priority to any one with respect to speculative ideas, since we have considered it our problem to show how far our experimental results were of significance to these now familiar ideas. We made a small step forward in giving a quantative proof for the cosmic origin of the radiation in 1925, in that the longest wavelength observed, according to our method of calculation, agreed with the Einstein equation corresponding to the building of helium out of hydrogen; and last winter, (February, 1927) we found clear and authentic proof that this and other atom building processes are actually the source of the cosmic radiation. We proved further, contrary to all previous assumptions, aside, perhaps, from the assumption of MacMillan, that the atom building process does not occur in the stars, but in the depths of interstellar space.

If there is any one, besides Einstein, who was a pioneer in the development of the theoretical ideas for which we have found experimental proof, it is W. D. MacMillan. Any one, who, since 1918, may have sought to write the history of the atom building processes should have given him a deserved recognition.

EXPLORER'S PREDICTION FULFILLED.

Stockholm, Aug.—The prediction by Dr. Sven Hedin, noted Swedish explorer of Central Asia, that in 25 years the River Tarim in Chinese Turkestan would abandon its course and return to an ancient channel farther north has now been fulfilled, according to a communication received here. The river is running now where it did 1,600 years ago.

Dr. Hedin's attention was called to the wandering stream when he tried to follow a Chinese map 1,600 years old. It appeared that the Chinese geographers had made a mistake, for the river on the map was not on the landscape, but instead there was a "new" river to cross 550 miles away. After studying geological conditions, Dr. Hedin justified the Chinese scholars and their map, by explaining that the southern branch of the Tarim apparently swings back and forth like a pendulum. He predicted then that the accumulating silt would soon drive the river to seek its old course.

SCIENCE AND ITS RECOGNITION IN THE HIGH SCHOOL CURRICULUM.

By A. C. Monahan,
Formerly U. S. Bureau of Education.

Glance at the magazines in the stand on the side of the road, in the railroad station, or elsewhere, and note the number of different science magazines on sale. Look in the daily newspaper and note the science articles published, most of which are furnished them from at least three different syndicates. Turn the pages of any of the well-known first-class general magazines and count the number of special articles on science. All of this is proof of the general interest in the subject on the part of the reading public. It is evidence that science and developments resulting from science research are a matter of great popular interest.

With this interest on the part of the general reading public, one would expect a greatly increased interest in the sciences among high school pupils and a greatly increased enrollment in the science classes. Such is not the case. While the actual enrollment *has* increased, it has not increased in the same proportion as the total enrollment in the high schools as a whole. The percentage of students in science classes to the total enrollment is constantly on the decrease, and has been during the past decade at least. Some of the reasons are given below. First it might be stated that science instructors apparently have failed to note the popular demand for science reading on the part of the general public, and to make use of this fact to develop a corresponding interest on the part of pupils in the school. Science instructors want a larger enrollment, for it gives them and their department more prestige and makes it easier for them to get a proper allotment of funds to purchase the necessary equipment to give an up-to-date course. They should take steps to secure it.

While this statement about the failure of the science men to find means of popularizing their departments is true on the whole, there are some notable exceptions. In various parts of the country are men and women who have found ways of successfully developing their science

classes. This article and others to follow will report on some of them. First it will be well to review the actual enrollment situation, and some of the trends as shown by studies recently made of a nation wide character.

SCIENCE STUDENTS IN PUBLIC HIGH SCHOOLS.

	1915		1922		1928	
	Students	Per cent of total	Students	Per cent of total	Students	Per cent of total
Total enrollment	1,165,495		2,155,460		2,896,630	
Physics	165,854	14.2	192,380	8.9	198,402	6.9
Chemistry	86,031	7.4	159,413	7.4	204,694	7.1
Biology	80,403	6.9	189,288	8.8	393,183	13.6
Botany	106,520	9.1	82,241	3.8	46,062	1.6
Zoology	37,456	3.2	32,956	1.5	22,175	0.8
General Science			393,885	18.3	507,026	17.5
Physical Geography	169,911	14.6	92,146	4.3	78,759	2.7
Astronomy	3,224	0.3	1,474	0.1	1,632	0.06
Geology	5,558	0.5	3,520	0.2	2,548	0.1
Hygiene-Sanitation			130,728	6.1	227,054	7.8
Physiology	110,541	9.5	109,519	5.1	77,632	2.7
Agriculture	83,573	7.2	110,242	5.1	105,911	3.7
Home Economics	150,276	12.9	307,553	14.3	477,427	16.5
Manual Training	130,155	11.1	226,023	10.5	361,657	12.5

Included with this article is a table made up of official figures from the U. S. Bureau of Education. It gives the actual enrollment in the various sciences in the public high schools of the United States for 1915, 1922, and 1928. The figures are quite complete, those for 1928 including data from 14,725 high schools in which were enrolled approximately 86.3 per cent of the entire public high school enrollment.

The science teacher will be much interested by a careful study of these figures. He will note first that the enrollment in Physics has had a considerable decrease. Chemistry about holds its own. It has done so largely because of the efforts of several national agents in promoting an interest in the subject. The Chemical Foundation of New York has been giving prizes to high school pupils for essays on chemistry subjects. Chemical Education, a monthly journal for teachers, has taken on greatly increased activities due to a subsidy for this purpose. The Science News Service has given much publicity to

chemistry, and the American Chemical Society, through its permanent office in Washington, has been actively engaged in promotional work.

Biology shows a large increase in the figures in the table. It is made up however of enrollment formerly in Botany and Zoology. The increase therefore is not real. In fact the total percentage in biology, botany and zoology is less in both 1922 and 1928 than in 1915, but greater in 1928 than in 1922.

General Science came into the curriculum around 1900 under various names. It was not till 1922 that it became distinctive enough to warrant the Bureau's collecting data on enrollment in it under its present name. Its enrollment is largely those who would have been studying physical geography in 1910 or 1915. Physical Geography is fast disappearing from the curriculum in favor of General Science. Astronomy and Geology are also disappearing—they were never very popular.

Figures on Physiology, Hygiene and Sanitation are included in the table. The totals are about constant. Agriculture is also included. The percentage enrolled is decreasing. This is to be expected as the 1915 enrollment was at a period when agricultural education was receiving much boosting. The large increase in Home Economics is worthy of note, also the increase in Manual Training, which includes all shop and industrial work. This increase is especially worthy of note by science teachers as they will recall that the schemes adopted by manual training and shop teachers to get these subjects into the school program, and to get a large enrollment in them, were particularly successful. They consisted largely in advertising the departments. They had their pupils make simple articles of furniture and take them home to add to the home furniture. They had public exhibitions of articles made in the school shops placed in store windows so that the public could see them. They held special exhibits at the schools to which invitations were sent to parents, school board members and other influential citizens. The same plans can be used just as effectively by science teachers.

To go back to the table on enrollment in science

courses, one will note that four subjects now constitute the high school course in science subjects: General Science for the first year students, Biology for the second, Chemistry for the third, and Physics for the last. Hygiene and Sanitation continues but this subject hardly classifies with those just mentioned. Agriculture is taught in few schools now except those receiving an allotment of the Smith-Hughes money for vocational work and the courses have a vocational trend. Of the pure sciences, Astronomy, Geology, Systematic Botany and Zoology, and Physical Geography, have practically disappeared. It is to be noted that it is the *laboratory subjects* that have continued. It shows the students are interested in the activities in the laboratory. They like to do the individual laboratory experiments. This should suggest to the instructor one of the ways of improving his enrollment.

Further analysis of the table brings out another fact, over which teachers of Chemistry and Physics may well ponder; the proportional enrollment of Juniors and Seniors in Physics and Chemistry is not as great as that for Freshmen in General Science or Sophomores in Biology.

Of the 2,896,630 pupils enrolled in the public schools in 1928, approximately 35% were in the first year, 28% in the second, 20½% in the third, and 16½% in the fourth. The enrollment in General Science is almost wholly first year pupils, and in Biology very nearly all second year pupils. Chemistry and Physics are third and fourth year subjects, the more common practice being for Chemistry to precede Physics, although in many schools the reverse is true. If we assume that all the General Science students are Freshmen and the Biology students are Sophomores, then 50 per cent of the Freshmen and 48½ per cent of the Sophomores are in science classes. The total enrollment in Physics and Chemistry is only 37½ per cent of the number of students in the Junior and Senior classes. The writer is aware that these percentages are only approximately true as there are a considerable number of upper class men enrolled in Biology; on the other hand there is probably a number almost as great of lower class pupils taking Chemistry

or Physics. It is approximately true therefore that while nearly 50 per cent of the two lower classes are taking science courses, only 37½ per cent of the two upper classes are doing so.

The inquiring instructor will look for an explanation for the above. The writer has asked many science teachers, principals, and superintendents. They agree on a few reasons fairly well.

1. "Physics and Chemistry both have the reputation of being 'hard courses.'" This is particularly true of Physics because a large amount of mathematics is commonly included. Superintendents and Principals often say that the courses are too hard because the science teacher tries to give his high school pupils a college course, that being the only course he remembers.

2. "Many high school teachers make the mistake of using too much of their scheduled time for demonstration and lecture work, forgetting that they are dealing with pupils of an age when neither is effective. High school pupils are of the age when they crave physical activities, the individual laboratory experiment method furnishes this." An authority on teaching methods is responsible for this statement.

3. "Girls are not interested by nature in the physical sciences as they are in the biological, and the decrease is due to this fact." However true this may be relative to Physics it ought not affect the enrollment in chemistry as a large percentage of the courses in Home Economics require courses in chemistry.

4. "Superintendents and Principals often discourage enrollment in the science classes (according to some science teachers) because the science courses cost more to maintain than do courses in academic subjects." It is true that the equipment and supplies for science work cost more than that for text book subjects, but they do not cost more than the courses in home economics, art, manual training, and physical education, for which funds are allotted without question.

These few statements will perhaps give the science instructor some of the suggestions relative to the steps necessary to give his department more prestige and to increase the enrollment in his various classes.

1. He must make his courses vital, practical and interesting to compensate for their "hardness." This applies especially to Physics and to a less degree to Chemistry. Much of the mathematics of both courses can well be omitted except for those students who are going to college. Individual laboratory experiments will please the students and should be provided even though it makes more and harder work for the instructor and takes time now given to classroom discussions on theories involved.

2. He should take steps to interest lower class pupils

in upper class sciences. Demonstration talks in the school auditorium, given by the science teacher and by upper class students, with more or less spectacular experiments in Physics and Chemistry, have proven their effectiveness.

3. He must find methods of showing school authorities and the public that the cost of the science department is justified. Similar demonstrations to those suggested, given before parent-teacher associations and other public gatherings, are effective.

How some of the above plans are being worked out by various instructors will be discussed in following articles, as will also the relative cost of science instruction and instruction in other departments of the high school.

FROM THE SCRAPBOOK OF A TEACHER OF SCIENCE.

By Duane Roller,
The University of Oklahoma, Norman, Okla.

Mathematics is the class of all propositions of the form, P implies Q.—*Bertrand Russell, "The Principles of Mathematics."*

Mathematics is the queen of the sciences and arithmetic the queen of mathematics. She often condescends to render service to astronomy and other natural sciences, but in all relations she is entitled to the first rank.—*Gauss.*

Marriage is the square of a
plus b
In other words
a^2+b^2+2ab
where 2 ab (of course)
are twins.
—*Christopher Morley, "Translations from the Chinese."*

It is remarkable that a science (probabilities), which began with the consideration of games of chance, should have become the most important object of human knowledge.—*Laplace, "Exposition du système du monde."*

I often say that when you can measure what you are speaking about and express it in numbers, you know something about it; but when you cannot express it in numbers, your knowledge is of a meager and unsatisfactory kind; it may be the beginning of knowledge, but you have scarcely in your thoughts advanced to the stage of science.—*Lord Kelvin.*

Man without tools is nothing—with tools he is all.—*Carlyle.*

Western civilization is derived from three sources: the Bible, the Greeks, and Science—the last operating chiefly through machines.—*Bertrand Russell in "Whither Mankind."*

INVERTING THE DENOMINATOR OF A FRACTION.

BY G. A. MILLER,

University of Illinois, Urbana, Ill.

One of the most useful rules for dividing by a fraction is to invert the denominator and multiply. Hence it may be of interest to consider here several historical statements relating thereto, especially since the interest in the history of fractions has been greatly increased recently by the publication of translations of the *Rhind Mathematical Papyrus* by T. Eric Peet, A. B. Chase, and others. On page 135 of volume 1 (1921) of the favorably known *Geschichte der Elementar-Mathematik* by J. Tropfke it is stated that this rule appears for the first time in the *Arithmetica Integra* (1544) by M. Stifel. This is not quite correct since it has been found explicitly stated at a considerably earlier date in the mathematical literature of India but it does not seem to appear in the mathematical literature of Europe before the sixteenth century. The late appearance of this explicit rule is one of the most astounding facts in the history of fractions, especially if we consider the elementary character of the rule and the fact that fractions received so much attention even at the time when the *Rhind Mathematical Payrus* was written.

Another interesting statement relating to this rule appears on page 226 of volume 2 (1925) of D. E. Smith's *History of Mathematics*, and reads as follows: "Influenced by the notion that only fractions could deal with fractions, medieval writers often substituted for the division of a fraction by an integer the process of multiplying by the reciprocal of the integer; that is, $\frac{2}{3} \div 4 = \frac{2}{3} \times \frac{1}{4}$." This statement seems also to require slight modification, for when a student operates with fractions he obviously deals with fractions, and the medieval writers cannot have had the notion that such dealings implied that the student was a fraction. On the other hand, those who are actuated by the dictum, "Prove all things; hold fast that which is good," will find also valuable historical information in this statement.

These quotations may serve to illustrate the wide difference which often exists between formulated mathematics and implied mathematics. The history of the former is

comparatively easy since it involves merely the recording of actual statements, while the history of the latter involves the exercise of judgment, and is subject to differences of opinions. The process of inverting the denominator and multiplying when dividing by a fraction is so elementary and useful that it now appears in nearly all of our own elementary treatises on fractions, and yet its formulation does not seem to appear even in the extant mathematical literature of the ancient Greeks which is so rich in carefully formulated rules relating to theoretical mathematics. The fact that the operations of multiplying and dividing are reciprocal seems to have been recognized already in the noted *Rhind Mathematical Papyrus,* since problems in division are frequently verified therein by multiplying the results obtained by division.

In fact, the table which appears at the beginning of this work and in which the results of dividing 2 by the various odd numbers from 5 to 101 are expressed in terms of unit fractions, may be intended to give the double of the reciprocals of these odd numbers in terms of the sums of such fractions. According to the most elementary view of division the number 2 can be divided only by 1 and 2, while these special divisions are not explicitly given in this table. Hence the divisions which are noted here are only such as are impossible from this most elementary standpoint. When the ancient Egyptians said that 2 divided by 5 is $1/3 + 1/15$ they went further than we now commonly consider it necessary to go since we are usually satisfied with the symbol $2/5$ for this quotient. If they did not regard this quotient as a number then they cannot have regarded the sum of the two unit fractions $1/3$ and $1/15$ as a single number.

On the other hand, if they regarded the double of every unit fraction as a number it seems probable that they also regarded every quotient of two natural numbers as a single number in view of the fact that from their method of multiplying by doubling successively it seems to result that they assumed that every natural number is the sum of different powers of 2, including unity, or the zero power of 2, when the number is odd. Hence they probably assumed that the positive rational numbers form a group with respect to division. This view is in accord with the

existence of pre-historic group theory, and hence it is in agreement with the ideas recently expressed by A. Speiser in the introduction to the second edition of his *Theorie der Gruppen von endlicher Ordnung*, 1927, where the existence of this early group theory is supported by the early developments as regards regular geometric figures and ornamentations. It is noted here that these figures could be comprehended only by means of group theory concepts, and hence this pre-historic group theory is implied but not formulated group theory. It may be added that the recent discoveries relating to the *Moscow Papyrus* show that the ancient Egyptians made mathematical advances that extend beyond what had hitherto been suspected.

The fact that the rule relating to inverting the denominator appeared in an explicit form for the first time several centuries after the beginning of the Christian era may also serve to emphasize the lack of unified methods in much of the early mathematical work. For instance, the table at the beginning of the *Rhind Mathematical Papyrus* was not constructed according to a single general method although such a method could readily have been followed. Moreover, the history of mathematics can be greatly simplified by emphasizing the comparatively late appearance of certain developments as well as the unexpectedly early appearance of other results. The effort to explain such apparently divergent results so as to secure a harmonious picture of the development of the entire subject is likely to provide interesting and comprehensive views relating to the history of mathematics and may throw some light on the relative ease with which the various subjects are likely to be mastered by the student. One reason why we now insist on unified methods is that we are in a hurry and desire to master as much as possible by a single effort. In earlier times this haste was not such a strong incentive and the students could enjoy at leisure many variants which we now feel are not sufficiently important to retard our progress.

LENGTH OF NEPTUNE'S DAY.

Dr. J. H. Moore of the Lick Observatory has discovered that the planet Neptune turns once on its axis in about sixteen hours. Only two of the larger members of the solar system remain whose length of day is unknown. They are Venus and Pluto.

A SCIENCE AUDITORIUM PROGRAM.

By Carl F. Hanske,

Emmerich Manual Training High School, Indianapolis, Ind.

Extra curricular activities programs advocated by modern education have expanded rapidly in recent years since authorities generally have come to recognize the pedagogical values to be derived from activities which utilize the spontaneous interests of pupils in promoting the advancement of one or more of the cardinal principles of education. As one phase of a constructive policy for the school's extra curricular activities program, the various departments of our school have been presenting representative auditorium programs the past two years which have called for direct pupil participation in organization and presentation. The details of one of these programs, recently prepared by teachers and pupils of the science department, are presented in the account which follows.

The program, designed for the limits of a forty-minute period, provided for participation on the part of about twenty-five pupils. It was planned especially to secure the benefits of the division of labor so as not to call for too much time on the part of any one teacher or pupil. A scenario of the body of the program, and the various demonstrations to be performed, was drawn up in detailed form, and mimeographed copies of the same were given to all teachers and pupils concerned. One teacher was assigned to supervise the rehearsals of the principals in the cast; other teachers in the department were assigned to supervise the individual demonstrations independently of the rest of the cast. When these separate rehearsals had been satisfactorily completed, all groups were called together for general auditorium rehearsals. Only two such general rehearsals were necessary to co-ordinate the performance as a whole.

The following program in mimeographed form was passed out to pupils after they had been seated in the auditorium:

THE TRIUMPH OF SCIENCE

A playlet in one act presented by pupils of the Science Department.

CAST OF CHARACTERS

KING VODIODO	PRINCESS XEMA (youngest daughter)
THE PROFESSOR	PRINCESS DODO (eldest daughter)
THE SCIENTISTS	THE ROYAL NURSE
	KOFF AND DROP (guards of King)

SCENE

The Throne Room of KING VODIODO

Foreword

A number of scientists, under the direction of the Professor, have been engaged in exploring the land of Silopanaidni. They have just been captured by the soldiers of the King, who, by the way, has absolutely no use for scientists. He has, therefore, decreed that they are to be done away with by the Royal executioner, and the scientists don't like the idea at all.

The Professor, however, pleads with the King; he tells him of the wonderful things that his scientists have accomplished, and promises to turn over to him many valuable scientific secrets if he will spare their lives. The King is not much impressed with all this talk, and wants to be shown. The Professor and his assistants then perform some of their remarkable experiments for him. Whether or not the scientists succeed in convincing the King remains to be seen.

As the curtain opens, the poor scientists are just being brought before His Majesty.

[*Just before the curtain rises, orchestra consisting of piano, trumpet and bass drum, begins to play a funeral march. The rhythmic tread of marching feet is clearly audible. The curtain rises slowly, and the scene is the throne room of the King. The King, with a crown upon his head and scepter in his hand, is seated upon the throne to the right-front of stage. The scientists, tied with ropes, and led by the Professor, are marched in to the music by the King's guards; the procession halts before the throne, and the guards take their stations. The music stops.*]

KING *(slowly and impressively)*: Professor, you have asked for an audience with me. I have already decreed that you and your assistants are to be done away with at sunrise tomorrow, as we have absolutely no need for scientists in Silopanaidni. Your time is very limited, so make haste, and tell me what your last request may be.

PROFESSOR: Your Majesty, we have done no wrong in coming to your great kingdom. To the contrary, we have been engaged in very important researches covering many different branches of science, and have accumulated a vast store of extremely valuable information. All these data we are prepared to turn over to you if you will spare our lives.

We have made extensive biological and geodetic surveys; we have located rich mineral deposits; we have made careful analyses of your water supplies, and have gathered im-

portant statistical data relating to agriculture, to your forests, your mines, your fisheries and other natural resources. Our engineers have great plans for the reclamation of desert lands by irrigation; our medical men have made important discoveries that will affect the public health of your kingdom; and our chemists, physicists, meteorologists, and biologists have equally valuable contributions to make.

Furthermore, if you will spare our lives, we will turn over to you information concerning many of the marvels and conveniences which science has furnished the world, and which will help to make your country more wide-awake, happier and more prosperous. I have listed here just a few of these products of the scientific age—if you will permit me to read them to you. *(Reads quite rapidly from the following list)*: The automobile, airplane, telegraph, telescope, microscope, television, phonograph, telephone, dictaphone, vitaphone, moving picture, radio, radium, rayon, insulin, vitamines, electric light, X-ray, vaccines, gas engines, steam engines, electrical appliances, celluloid, aspirin, flavors, dyes, perfumes, cosmetics, lip-sticks——

KING *(interrupting the Professor)*: Hey! Hey! Not so fast! Not so fast! What you say is all very interesting, if true. But, actions speak louder than words, and I've got to be shown before I swallow everything you say.

PROFESSOR: King, you speak like a true Missourian. Fortunately we are prepared, and we shall do our best to demonstrate some of the remarkable things we are capable of doing. If you will permit my men to get their apparatus from the laboratory, we shall be ready to begin at once.

KING: Okay, Professor!

(The King claps his hands and motions to guards who lead the prisoners out left-stage. Guards return and again take their posts. Assistants who are to perform the first demonstration enter with table bearing apparatus, and set the same towards front-center of stage.)

Demonstration No. 1

PROFESSOR: These young ladies are our chemists, and are apparently endowed with the power of performing miracles. In this pitcher they have plain water; from it, however, they are able to pour any beverage Your Royal Highness may desire. What drink would you wish?

KING: Give me some red wine, and let it be good, or you shall take the consequences!

(On the demonstration table are four battery jars. The first jar has a few potassium permanganate crystals on the bottom; the second, some barium chloride; the third, some crystals of potassium dichromate; and the fourth, a pinch of methylene blue dye. The water in the pitcher is acidulated with sulphuric acid. Assistants prepare "wine" by pouring from pitcher into the first jar. They hold it up for the King to see. The King smacks his lips, and motions for them to set the wine on a side-table near the throne.)

PROFESSOR: Again, name your drink, King!

KING: Milk!

(Chemists prepare "milk" by pouring from pitcher into the second jar. Hold it up for the King to see.)

PROFESSOR: Another one, King—and make it a hard one this time!

KING *(scratches his head—then chuckles)*: Orange-ade that will turn into Green River!

(Chemists pour from pitcher into third jar, then empty contents of third jar into the fourth. Hold it up for the King as before.)

KING: Quite interesting, Professor, but you'll have to do better than that if you expect to escape the axe.

(Professor dismisses chemists by motion of his hand. They carry their pitcher out with them. Assistants who are to perform the next demonstration enter, and place their apparatus on the table.)

Demonstration No. 2

PROFESSOR: Here are our specialists in electricity. They will give you a demonstration with some of their apparatus.

FIRST ASSISTANT: We call this apparatus an electro-magnet. It is the essential part of the electric bell as well as of the telephone, by means of which you may talk to citizens in all parts of your kingdom. Notice how powerful this electro-magnet is.

(Demonstrates by picking up various objects, such as nails, etc.)

SECOND ASSISTANT: This we call a static electricity machine. This, over here, is a Leyden jar which we can fill full of electricity. Stand back! Stand back! Danger!

(Discharges Leyden jar.)

KING: Lightning! Lightning!

SECOND ASSISTANT: No! Not exactly! But if you will spare our lives, we will gladly show you how to control this electricity and make it serve you in a thousand different ways.

(Assistants leave, taking apparatus with them.)

KING: Well, Professor, this is getting a little better. But what else have you got to show us?

PROFESSOR: Our radio men here have something very interesting for Your Majesty.

Demonstration No. 3

(Radio men enter. One carries a loop aerial and a microphone; the other wears head phones, and carries a loud speaker. Batteries, two-stage amplifier and microphone are back-stage in one of the dressing rooms. This room later serves as the broadcasting station.)

KING: Well, what have you got to say for yourselves? Don't stand there like a couple of dummies! Speak up!

(Radio men are visibly affected.)

FIRST RADIO MAN *(in a rather low and quavering voice)*: If it p-p-please Your M-M-Majesty, we are only a couple of young men trying to get along in the world.

(The King cups his hands to his ears and apparently can't hear what they are saying.)

KING: Why don't you speak up like men? If you have anything to say don't hesitate to do so. Come closer so I can hear you better.

(Radio men step closer, and hold loudspeaker directly in front of the King. First radio man shouts into the microphone.)

FIRST RADIO MAN: WELL KING! CAN YOU HEAR ME NOW—OR SHALL I SPEAK LOUDER?

KING *(almost falling off throne)*: For Heaven's sake! No! What kind of business is this? Is this what you call a radio?

SECOND RADIO MAN: No, this is only a speech amplifier. But say, King, will you spare our lives if we tune in on a radio program?

KING: That depends entirely upon the program.

(First radio man carries microphone off stage to dress-

ing room serving as broadcasting station, returns with a small receiving set which he places upon the demonstration table, and pretends to tune in. A series of squeals and other discordant sounds are heard through the loud speaker.)

KING: Terrible! Rotten! Take it away! Take it away!

FIRST RADIO MAN: Give us one more chance, King!

(Tunes in on some good music—viz: a cornet solo by one of pupils. Announcements of local school events are heard, then some more music. King appears much pleased.)

KING: Professor, this is getting much better. I might possibly save those radiomen—for a while anyway. *(To photographer, who has just entered)* Well, and who are you?

Demonstration No. 4

(Photographer sets up translucent screen on demonstration table, and a projection machine fitted with a film-slide adapter, behind the screen. Lights on the stage are dimmed.)

PHOTOGRAPHER: Now that Your Majesty has been shown the use and practicability of sound amplification, I shall show you some film-slides from a motion-picture I have taken for the purpose of studying your country. This film, which I call "Fathoms Deep" gives you a fine idea of the beauty spots and queer denizens of the sea bed. I sincerely hope that it will meet with your favor, and help to change your most disturbing attitude towards us scientists.

(Shows pictures on the screen. The King occasionally emits an "Ah!" an "Oh!" or a "Fine" during the showing of the film. The Professor reads an occasional title out loud, or points to some object in the picture.)

PHOTOGRAPHER: Your Majesty, I have many more equally interesting pictures which I would like to show you, but our geographers are waiting outside to show you what they have been doing.

(Lights come on. The screen and projection lantern are quickly removed as the geographers enter carrying transit, telescope, aneroid barometer, dip needle, etc.)

Demonstration No. 5

PROFESSOR: Your Highness, the members of the geog-

raphy department of this expedition have been engaged in exceedingly important work. They have kept us informed about the weather changes, and have studied the rivers, the mountains, soils, and the effects of weathering. They know all about latitude and longitude, map-making, volcanoes, glaciers, alluvial cones, cotidal lines, doldrums, eskers, igneous rocks, meanders, monsoons—

KING *(interrupting)*: Professor! Professor! You talk altogether too much. Let the men speak for themselves, and give your cords a rest.

TRANSITMAN: The use of this transit was made possible long ago when Galileo discovered the telescope. We will set its base level by means of these side bubbles. Then, by pointing it upward towards the sun we can read the angle of the sun's height on this arc at the side. *(Makes adjustments.)* Well, it reads 80 degrees. It is now half past ten on April 24th. I find we are in latitude 5 degrees north. If you will but give us an opportunity, we can survey a road to the coast for you.

And with this small instrument we can find our exact height above sea level. Levelman, explain your work to His Majesty.

LEVELMAN: Since leaving the ship I have been keeping a record of our height above sea level. Rodman, put up the rod. *(Looking through telescope.)* It reads three and twelve hundredths feet. *(Looking at field note-book.)* I find that we are 7,307 feet above sea level. Rodman, will you please check this up on your aneroid barometer?

RODMAN: I'll do my best, Levelman. For every one thousand feet we go up this barometer points downward one inch. You're right, Levelman. We are 7,307 feet up. *(Taking dip needle up and looking at its point.)* Your Majesty, do you notice how this needle points downwards? It is a sure sign that there are rich mineral deposits in the vicinity.

KING *(somewhat irritably)*: Yes, yes—that is all very interesting, but it taxes my brain too much, and I don't seem to understand it all very clearly. Professor, can't you show us something that isn't so intricate, and doesn't require so much concentration?

(Assistants leave stage.)

PROFESSOR: Yes, yes, Your Majesty! *(Louder.)* Bring in the transmutation machine!

(Assistants enter with a weird looking piece of apparatus fitted with a funnel, various assorted wheels and cogs, a spout on one side, radio dials, an electric bell, push buttons, etc. They set this on the demonstration table.)

Demonstration No. 6

FIRST ASSISTANT: King, you haven't seen anything yet. We have here the most wonderful machine in the world, so simple in construction that a child can operate it. In fact, no intelligence whatsoever is required to operate it—even Your Majesty might learn to operate it in time. This machine has solved the problem of the transmutation of the elements. It is a gold brick machine, and will make you the wealthiest man in the world. But, let us not waste time talking. We will instead proceed to lay a couple of gold bricks for you. Watch carefully the operation of the machine. First we turn on the ignition—like this. *(Turns on the ignition.)*

SECOND ASSISTANT: Then we pour some of this egg-nog into the radiator. *(Pours yellow fluid, i. e., solution of potassium chromate into the funnel.)*

THIRD ASSISTANT: Next we add a little of this Epsom salt, adjust the wave length, and we are ready to go.

(Assistants perform above operations and proceed to turn the crank. The machine is quite noisy. After turning the crank a few minutes, the gong sounds, and a gold brick drops from the spout of the machine. Several gold bricks are manufactured in this manner and presented to the King.)

PROFESSOR: Well, how's that, King?

KING *(very pleased)*: Not bad at all! I didn't think it was possible, but I saw it with my own eyes! I can appreciate that sort of thing, Professor.

(Assistants remove their machine. Assistants who are to perform next demonstration enter, and set their apparatus on the table.)

Demonstration No. 7

PROFESSOR: Your Majesty, I have noticed that a great many of your warriors are ill with fever. My men here will

tell you something of its causes, and how it may be prevented.

KING: That sounds very worthwhile to me, Professor.

FIRST ASSISTANT: O King, do you observe this large model of an insect? *(Holds up model.)* It is a model of the female anopheles mosquito which lays its eggs in marshy places. From these eggs the larvae develop in warm weather after several days. Since they are air breathers, they are easily destroyed by pouring petroleum upon the surface of the water. However, if these larvae are permitted to grow up into mosquitos, the danger is very great. An infectious disease known as Malaria, marked by chills, fever and sweating periods is caused through the introduction into the blood of hemameba or plasmodium malariae—

KING *(interrupting)*: My good man, go easy with all those big names. Remember we are not all medicine men.

FIRST ASSISTANT: I beg your pardon, King! But, notice what my helper is doing.

(Helper is busy with mortar and pestle. He is preparing a white fluid on demonstration table.)

PROFESSOR: My helper is preparing some magic medicine which we call quinine. It is very essential in the treatment of Malaria, and will help to cure your sick warriors.

(The Royal Nurse, very greatly agitated, comes running in here.)

NURSE: O, King! Little Xema has suddenly been stricken with a strange malady; our medicine men say that she is possessed of evil spirits, and that they can do nothing for her! What shall we do? What shall we do?

KING *(rising from his throne)*: What! My little Xema ill? Someone shall pay for this! Someone must do something about it right away—but what? *(Pauses.)* Aha! I have it! *(Points at the Professor.)* Professor, here is your golden opportunity! I solemnly promise you that if you will cure my little daughter, you and your men shall be freed immediately. And not only that, you shall have my eldest daughter, the Princess Dodo, for your bride.

PROFESSOR: King, you honor me, and I am deeply grateful to you for the opportunity afforded me. *(To the guards.)* Bring in the poor child.

(Guards bring Xema in on a cot, and place her before the

King. The King attempts to go to her but the Professor motions him back. The assistants [Demonstration No. 7] make a rapid examination, then whisper to the Professor.)

PROFESSOR: Your Majesty! You are very fortunate to have us here at this time. My assistants report that Xema has a slight case of Malaria. But do not be unduly alarmed. I am quite certain that we can fix her up in a twinkling. A little of this quinine, which my men have just prepared, should quickly cure her.

(Pours out a glass of white fluid [milk] and gives it to Xema to drink. Xema makes a wry face at the audience, but hops from the cot, takes her doll, and skips to throne. The King takes her in his arms.)

PROFESSOR: There you are, King!

KING *(deeply moved)*: Professor, I may be wrong, but I think you're wonderful! You have clearly demonstrated to me the wonders of modern science, and have saved the life of my little daughter. You and your men are free to pursue your researches without further molestation. *(In a loud voice.)* Dodo! Come in and meet the Professor!

(Dodo, with a crown upon her head, neat, but otherwise utterly unattractive, comes in, and smilingly gives her hand to the Professor. The Professor is dumbfounded, and for once, has nothing to say.)

KING: Bless you, my children!

(The Professor takes one look at the Princess, puts his hand up to forehead, rolls his eyes upwards, and steps to front of stage facing audience.)

PROFESSOR: Oh, Death! Where is thy sting?

(Orchestra plays the strains of a wedding march, and the curtain closes.)

MORE SOLID CARBON DIOXIDE NOW USED THAN ANY OTHER FORM.

Cincinnati, Sept. 10.—More solid carbon dioxide, commonly known as "dry ice" is now used than the liquid form of the gas, in which it was formerly marketed. D. H. Killefer, chemist of the Dry Ice Equipment Corporation, New York City, told members of the American Chemical Society that nearly thirty thousand tons of this former laboratory curiosity will be used during 1930. This is greater than the total amount of liquid carbon dioxide used in 1927, the latest year for which figures are available. It is used for refrigeration, because of its advantages over ice in being colder and in not melting, but changing directly from the solid form into the gas.—*Science Service.*

COLLEGE STUDENT'S KNOWLEDGE OF PLANE GEOMETRY.

BY H. J. ARNOLD,

Wittenberg College, Springfield, Ohio.

Like algebra, geometry still occupies an important position in the American high school curriculum. While its commanding place in the course of study can probably no longer be justified solely on its traditional value as a mental discipline, it is nevertheless true that geometry, as the science of space relationships, seems to have some elements which are useful in college work. On the other hand, plane geometry is still required for graduation in the great majority of high schools of the country and is likewise listed as an entrance requirement by most colleges, notably colleges of engineering and science.

For these reasons, it seemed justifiable to undertake a study of college students' abilities and disabilities in plane geometry as one part of a more extensive survey[1] of students' background preparation for college work.

The Schorling-Sanford Achievement Test[2] was selected

TABLE 1—DISTRIBUTION OF TEST SCORES OF 80 COLLEGE STUDENTS IN THE SCHORLING-SANFORD ACHIEVEMENT TEST IN PLANE GEOMETRY, SHOWING (A) FREQUENCY DISTRIBUTION OF SCORES FOR EACH OF THE FIVE PARTS (B) PERCENTAGES OF ZERO SCORES MADE IN EACH PART.

Total Score	I. Completing sentences	II. Drawing conclusions from Data	III. Judging Correctness of Conclusions	IV. Analyzing Constructions	V. Computations
12	....	....	....	....	....
11	....	....	....	....	....
10	3	....	....	2	3
9	2	....	2	6	2
8	8	....	1	9	6
7	19	2	17	9	6
6	*19M*	3	20	*17M*	18
5	12	7	*1M*	10	*13M*
4	10	12	16	19	10
3	5	*21M*	11	1	11
2	1	20	....	7	9
1	....	10	6	....	2
0	1	5	6	....	....
Group Median	6.6	3.2	5.5	6.2	5.6
Per cent Zero Scores	1%	6%	7%	0	0

[1]Arnold, H. J. An Analysis of Some of the Elements of Previous Preparation of College Students and the Relation of these Elements to Academic Standing. Ph.D. Dissertation, Ohio State University. 1929.

[2]Form A was used. The test consists of five parts of twelve questions each.

for the investigation. Eighty students, approximately 90 per cent of whom were freshmen, took the test in accordance with the prescribed regulations.

Results.

Table 1 gives (1) a distribution of the scores, (2) the group medians and (3) the percentage of zero scores obtained by 80 students in each of the five tests.

Table 2 shows the distribution of the total scores together with the percentages at and below the standard percentile levels.

Table 2—Distribution of Total Test Scores Made by 80 College Students in the Schorling-Sanford Achievement Test in Plane Geometry, Showing Percentages Below Standard Levels (Q3) (M) and (Q1). Also Percentages not Exceeding Scores of 20, 24, 26, 28, 30, 33, 35 and 41 For High School Geometry Classes (Norms Based on 695 Cases).

Total Score	Frequency	Standard Percentile Levels	Percentages Below
		90	
40			
39	1		
38	2	75 Q3	96
37	1		
36		70	
35	1		
34		60	
33	3		
32	3M (Stand)	50M	86
31	4		
30	3		
29	3	40	
28	5		
27	6	30	
26	2	25 Q 1	57
25	9M (Group)	20	
24	5		
23	6		
22	3		
21	2	10	26
20	6		
19	3		
18			
17	2		
16	2		
15			
14	2		
13	1		
12	2		
11			
10	1		
9	1		
8	1		
7			
6			
Total	80		

SUMMARY

Not Exceeding	Standard Per Cent	Per Cent of Group	Difference
Score of 20	10	26	16
Score of 24	20	46	26
Score of 26	30	67	37
Score of 28	40	77	37
Score of 30	50	86	36
Score of 33	60	93	33
Score of 35	70	95	25
Score of 41	90	100	10

Results from test to test (Table 1) show that the largest percentage of low scores was made in Part II (drawing conclusions) and in Part III (judging correctness of conclusions). In these two parts also occurred 11 of the 12 zero scores made in the test, suggesting rather marked difficulty centering around (1) conclusions to be derived from geometric data, and (2) judging the correctness of certain conclusions. However, the nature and extent of the actual geometric disabilities are more clearly shown in the error analysis which is summarized further on.

The distribution of total scores (Table 2) shows that 86 per cent of the group fell below the standard median, total score 31, while 26 per cent of the group scored below the standard 10 per cent level. Only three students received scores at or above the third quartile level and not a single one scored above the 90th percentile which represents a total score of 40 out of a maximum of 69.

The error analyses disclose an astounding variety of incorrect answers in the three parts (I, IV, V) analyzed. In Part I (completion exercises), a total of 102 different incorrect answers were given for the 27 blanks to be filled. This means an average of 4 different incorrect answers for each blank. Some of the errors occurring with the greatest percentage of frequency in Part I, are the following: (1) confusion of formulae for area and circumference (Ex. 5), 32%; (2) substitution of "altitude" and bisector for "median" (Ex. 6), 31%; (3) substituting "angle" for "side" (Ex. 3), 24%; substitution of "equal" for "propor-

tional" (Ex. 4), 30%; confusion of parallelogram and rectangle (Ex. 11), 35%.

To indicate the variety of typical incorrect answers obtained, a few illustrations are given below. The numbers indicate the percentage of frequency of each incorrect answer. Correct answers for the blanks are capitalized.

No. 10. The Greek letter π represents the (a) RATIO of the (b) CIRCUMFERENCE of a circle to its (c) DIAMETER

(a)		(b)		(c)	
(blank)	25	(blank)	30	(blank)	31
relation	22	diameter	25	circumference	38
3.1416	3	radius	15	area	5
square	3	circle	5	1800	1
quotient	3	area	2	proportional	1
.2-2/7	1	square of radii	2	radius	5
circumference	1	distance	1		
half	1				
radius	1				
content	1				
diameter	1				
length	1				
proportional	3				
distance	1				

No. 11. A (a) RECTANGLE whose (b) SIDES are (c) EQUAL IS A square

(a)		(b)		(c)	
(blank)	13	(blank)	14	(blank)	14
polygon	3	angles	10	parallel	3
figure	14	4's	1	right angles	3
quadrilateral	16	4 sides	3	right	1
parallelogram	35	area	1	same	1
parallel	1			90°	1
cube	1				
triangle	1				

The results obtained seem to furnish rather abundant evidence of students' unfamiliarity with common fundamental definitions. Thus, 32 per cent indicated that πr^2 is the formula for the circumference of a circle, while 25 per cent stated that it represents the ratio of the diameter to the circumference. 35 per cent said a parallelogram whose angles are equal is a square, while 20 per cent indicated that "if equals are substracted from unequals" the remainders are equal.

In the analysis of constructions (Part IV) a corresponding variety of incorrect answers were given. At total of over 80 different incorrect answers were given for the 12

construction exercises, an average of 6 for each problem. An average of 31 per cent gave no answers whatsoever to 11 of the 12 exercises, which probably means that they were unable to deal with this type of geometric problem at all. 13 per cent were unable to distinguish between an isosceles and a right triangle (Ex. 41), 17 per cent failed to see the difference in construction between an inscribed and a circumscribed triangle (Ex. 43), while 13 per cent could not form a proportion showing the relation between the corresponding sides of two similar triangles (Ex. 38).

In construction exercises the chief difficulties disclosed by the results, seem to be: (1) unfamiliarity with certain basic theorems and propositions; (2) confusion of various classes of triangles; (3) inability to deal with proportion exercises and proportional relationships; (4) locus problems; (5) failure to read directions correctly. It seems quite likely also that guessing was resorted to in a few cases although there is no direct diagnostic evidence of this fact.

Computation problems (Part V) indicate approximately the same types of difficulty as were found in connection with construction problems. 104 different incorrect answers were given for the 12 problems involving computations, an average of 9 per problem. Answer spaces were left entirely blank by an average of 18 per cent, which is approximately half of the omissions in the construction test.

The largest percentages of errors and omissions, according to the error analysis (Part 5), were occasioned by the following types of computation exercises: (1) calculation of angles (Ex. 60, 55, 54, av. 78%); (2) calculating areas of triangles (Ex. 58, 59, av. 80%); (3) calculation of radius and circumference of circles (Ex. 49, 56, av. 63%); (4) area of parallelogram (Ex. 53, 56%); (5) finding proportional segments of a line formed by intersecting chords (Ex. 52, 55%).

There is also some indirect evidence of guessing in the case of several exercises and omissions (blanks) occur with rather startling frequency it appears from the error analysis.

Inferences and Suggestions.

From a survey of the results as a whole, it seems quite

evident that the chief difficulties group themselves about certain error types, which have been previously mentioned in some detail. In some instances, the difficulty may be traced directly to arithmetical deficiencies such as simple multiplication and division, the solving of ratios, proportions and simple equations. In general, the large variety of answers used in filling the blanks seems to indicate that many students show a marked deficiency in certain simple geometric facts.

The most outstanding difficulty appeared in connection with the exercises in which conclusions were to be drawn from given data (Part II). The 12 exercises in this test were missed entirely by an average of 22 per cent of the group, as against an average of 18 per cent in the same number of exercises in the computation test, in which a different type of deductive thinking is required.

It is suggested that the unfortunate practice of many geometry teachers and textbook writers, that of presenting theorems in such a way that the thinking as largely done for the pupil is partially to blame for this situation. In many instances even the conclusions are drawn by the teacher. Not a single discovery is left to the pupil. Geometry teachers know that under such circumstances it is possible for a pupil to memorize proofs without gaining the slightest conception of the reason for the various steps given. Obviously, such teaching destroys the very purpose of geometry. A student's ability to judge the validity of a conclusion depends, to be sure, on his knowledge of geometrical relationships. Such relationships are established through figure construction, definitions, theorems and original exercises.

Ability of college students to use geometric facts in computation is indicated by the results of Part V of the test. Here, also the deficiency was rather marked, reflecting again the students' unfamiliarity with basic theorems and other propositions. For example, 41 per cent could not compute the angle formed by two intersecting chords when the values of both were given (Ex. 55). While this is a comparatively simple computation, only 19 per cent solved it correctly; 40 per cent did not work the problem at all, while the 41 per cent who obtained wrong answers

gave 11 different results ranging from 90 to 230 degrees. This is quite typical of the results obtained in all twelve problems constituting Part 5. In a problem requiring the finding of the area of a parallelogram when two adjacent sides and the altitude were given, 12 incorrect answers ranging from 11 to 560 square inches were given by 36 per cent of the group. There would seem to be but one explanation for such a situation—lack of knowledge of the basic theorems and formulae, resulting in sheer guessing at the correct answer.

SUMMARY.

This article deals with the abilities and disabilities of college students in plane geometry, as disclosed by the Schorling-Sanford Achievement Test.

The study revealed that 86 per cent of the group tested scores below the standard median and 57 per cent below the 25th percentile, while 26 per cent made scores which were below the standard 10th percentile.

While the test disclosed a striking lack of knowledge of basic geometric facts based largely on definitions, theorems and formulae, the most outstanding difficulty appeared in connection with the drawing of conclusions from given data. Computation proved almost equally troublesome, the difficulty in both these tests apparently being due to a lack of knowledge of fundamental theorems, definitions and formulae.

A variety of errors appeared traceable to arithmetical and algebraic deficiencies such as simple multiplication and division, and inability to solve simple equations.

Construction difficulties appear to be traceable directly to lack of knowledge of fundamental theorems and other propositions ordinarily learned early in the course. There is considerable evidence of students' manipulation of symbols without the slightest comprehension of their significance.

BAD HEALTH A CAUSE OF LABOR TURNOVER.

More than one out of every ten resignations from the sales force of a department store are due to health conditions, a study conducted by Dr. C. J. Ho at the R. H. Macy and Company (New York) department store revealed. More women than men leave because of ill health, and resignations for this cause are more frequent in the spring than in other parts of the year.—*Science Service.*

GENERAL PRINCIPLES OF UNITARY ORGANIZATION.

By C. A. Stone and J. S. Georges,
The University High School, Chicago.

Division of teaching materials to facilitate learning and teaching: A careful examination of a textbook dealing with instructional materials reveals the fact that the content is usually divided into distinct parts. The purpose of this division is to facilitate the teaching and the learning of the processes, principles and concepts of the subject to be taught. No author, regardless of his ability to organize materials, would attempt a presentation that did not have some orderly arrangement or development of subject matter and expect pupils to acquire those habits, skills, appreciations and understandings which are the aims of the text. If many habits or skills are to be taught it is frequently desirable to teach a portion of the assimilative material that would tend to make them automatic before proceeding to the next portion. Again the knowledge of certain principles and concepts in a given part of the subject matter may be necessary before the pupil is enabled to attempt the succeeding work. In either of the above situations it is readily seen that teaching and learning would take place more easily if subject matter were broken up into distinct divisions. When such divisions conform to certain criteria, which will be discussed in detail later, they are known as units.

At this point the following questions might arise; "How many divisions should there be in a given course?" "Where are the dividing points?" In answering these questions it may be stated that the division of subject matter is of course arbitrary. The size and the nature of the divisions will depend entirely upon the subject matter, the level of maturity of the pupil, the objective that the teacher has in mind and the principles used. Some of the procedures that have been used in breaking up a course of mathematics into significant parts for purposes of instruction are as follows:

1. *The chapter plan.* In teaching mathematics the teacher as a rule uses a textbook and follows the organization of the author closely. This is either done because it is believed that the textbook writer is in better position to select and organize instructional material than the individ-

ual teacher, or for economy; the average teacher does not have the time nor the facilities for curriculum construction. The chapters of the textbook thus from necessity become the units of instruction.

This plan is open to criticism because the chapters of textbooks are not always organized upon the principles of unitary selection and instruction. Instead of centering about a fundamental concept or principle as a given goal or objective, the instructional materials contained in chapters of textbooks often have no explicit relation. The chapter objective is apparently ground to be covered. It is not uncommon to find chapters in mathematics textbooks dealing with topics that are neither mathematical in nature nor in significance, and hence cannot be considered as significant parts of mathematical courses. The chapter plan will be shown to be found wanting when evaluated in terms of the criteria for unitary organization.

2. *Modified chapter plan.* Frequently the chapters of a textbook are taken as units of instruction for the course, but supplementary instructional materials from other texts are freely used to modify the presentation and the organization of the author. The teacher employs this procedure because of the belief that much is to be gained by utilizing the methods and points of view of different authors. This plan is open to the same criticisms voiced above. However, the plan can be carried out successfully if the teacher is capable of weaving together the materials selected for instruction about some important mathematical concept or process. But this will involve reorganization of the plan of treatment as well as the instructional materials, and in that sense ceases to be a chapter organization.

3. *The project plan.* Here the course is divided into a certain number of "projects," and the instructional material is organized on the basis of its relation and application to some particular task or project. The projects may be real or artificial life situations. It is understood that the project is to be a constructive piece of work and aims to teach pupils an important aspect of mathematics through interest or motivation. There is no doubt that properly handled, the project offers large possibilities for teaching and learning mathematics through practical applications.

However, the plan is open to many serious objections. In the first place not all teachers are capable of carrying such projects to a successful completion. In the second place the project may become the thing of prime importance, and the mastery of the principles or concepts of mathematics which was to be the desired end is lost sight of entirely. In the third place not all pupils are capable of carrying projects and hence the plan fails. Experience has shown that this method of teaching is really successful with mentally superior pupils only.

4. *The social needs plan.* In this case it has been assumed that the social needs of children have been determined . By this is meant not only the present day activities, needs, and interests of the school children, but the activities, needs and interests they ought to have in order to develop the individual into a competent and intelligent member of the social group. These needs are then used as a basis for selecting those mathematical processes or principles for units of instruction which will enable the class to meet such needs. Materials for instruction are then selected from one or more textbooks. However, an examination of the literature dealing with analysis of the social needs of children reveals that they do not always determine the present mathematical needs of children but contingent values of mathematical instruction. At best child-activity analysis can only supplement other criteria for the determination of the objectives in the teaching of secondary school mathematics.

This plan is rather a basis for the selection of learning products and not a genuine plan of organization of the instructional materials. After the aims of instruction have been identified, instructional materials must be properly selected and conveniently organized for the attainment of the aims. Hence, this plan must be supplemented by some definite plan of organization.

5. *Concepts plan.* A plan superior to those previously mentioned, selects the fundamental procession, principles and concepts which are treated and developed in the text, and uses them as central themes about which the subject matter of mathematics is organized and arranged into units of instruction. The chapter arrangement is disregarded and the text is used merely as a source of material. Al-

though this plan is to be preferred to those that precede it, the limitation to one textbook for the selection of materials is an objectionable feature.

6. *Modified concepts plan.* The ideal plan of organizing subject matter into units of instruction is that plan whereby the fundamental mathematical processes, principles and concepts treated in several textbooks are chosen as units, and instructional materials from several textbooks and other sources are used to supplement the required textbook. The advantage of this plan over the concepts plan is that the teacher is given more freedom in the selection of processes, principles, concepts and assimilative material that will be used to develop such processes, principles and concepts. This plan is known as the unitary organization plan and its exposition will constitute the theme of this series of papers on unitary organization and unitary instruction.

Division for the purpose of measuring progress. The division of a course into units of instruction facilitates the recording or appraisal of pupil progress. By means of the credit system for courses or examinations on chapters of work a true appraisal of the pupil's educational development cannot be obtained. The fact that a pupil is given credit for a course or obtains a grade of 93 on an examination is in no way an assurance that he has mastered the underlying principles of the course, or that his understanding of the principles is complete. As will be shown, each unit of instruction stands for significant knowledge which can be tested and identified. Therefore it is possible to determine whether the pupil has mastered the unit or whether he has not. If he has, he is ready to proceed with the next unit. If he has not, he must study more material dealing with the unit or else he must be further taught, until his understanding is complete.

The plan of unitary organization offers the following advantages in the true appraisal of pupil progress, and the consequent crediting of instruction:

1. The course is evaluated in terms of actual learning of distinct mathematical concepts, processes and principles.

2. When each unit is completed, the actual learning products are identified before a new unit is attempted.

3. The accomplishment in each course is expressed in terms of the number of units learned and completed, and not in terms of ground covered or time spent.

Unitary organization is an attempt to make teaching more effective. One of the purposes of unitary organization is to make teaching more effective and thus reduce mortality and failures. The traditional methods of instruction did not take into consideration the varying needs and capacities of pupils. The teaching being of the mass instruction type was necessarily aimed at the "average pupil." To a large extent this was also true of teaching materials. Thus the slow pupil who was below average in ability either struggled to keep pace with the class or failed. The brighter pupil completed the work with ease and quite often wasted time in loafing and frequently became a problem in discipline.

With the coming of the newer methods of teaching which provided for individual differences it has been found that the traditional methods of organizing subject matter are not entirely satisfactory. In order to provide for individual differences it is necessary to change to a plan of organization which makes it possible to arrange instructional materials adapted to that purpose. While the essentials of a unit are the same for the whole class, teaching materials, exercises, and problems vary with different abilities and preparations of the pupils.

By means of unitary organization it is possible to provide motivation by working out projects in terms of certain aspects of the principles of the unit that may not economically be developed in the classroom. By this means the more capable pupil is provided for and kept interested in his work.

By this time the reader is no doubt wondering just what is meant by a unit of instruction. The writers will attempt to answer this question in subsequent papers. They have set up seven criteria to which materials of instruction must conform before they may be accepted as units of instruction. These criteria will be supplied to organizations selected from several existing sources to determine whether they constitute units of instruction or not. The criteria will be used in selecting materials for units, and in undertaking a technique for constructing units of instruction in mathe-

matics. Type units will be given and teaching procedures related to each unit will be discussed in full.

The criteria of unitary organization. The seven general principles* applying to unitary organization are:

1. Each unit of instruction must furnish definite learning products, which automatically become the definite aims of instruction to be attained in the unit.

2. Each unit of instruction must be based upon a central theme. A basic or fundamental concept or process may well be the central theme around which the materials of the unit are organized.

3. The central theme of each unit must be a significant part of the course in mathematics. The course consists of a sequence of closely related units.

4. Each unit of instruction is composed of definite and distinct unit-elements. The unit-element bears the same relation to the unit as the unit bears to the course, or the sequence of units.

5. The assimilative materials of each unit must center about and be focused upon the principal concept or process which is the theme of the unit.

6. Each unit of instruction must be teachable, i. e., the definite aims must be attainable through the assimilative materials as presented and developed in the unit and at the level where presented.

7. Each unit must be measurable, i. e., it should be possible to determine whether the learning products of the unit are attained or not.

Definition of a Unit of Instruction. A body of instructional materials organized to conform to these seven principles will be called a *unit* of instruction. The set is assumed to be complete and unitary organization of instructional materials is to be evaluated in terms of these criteria. Sound organization and purposeful teaching should enhance the value of mathematical instruction in secondary schools.

*The authors are indebted to Professor H. C. Morrison for the general principles which are the basis of the criteria for unitary organization here presented in modified form.

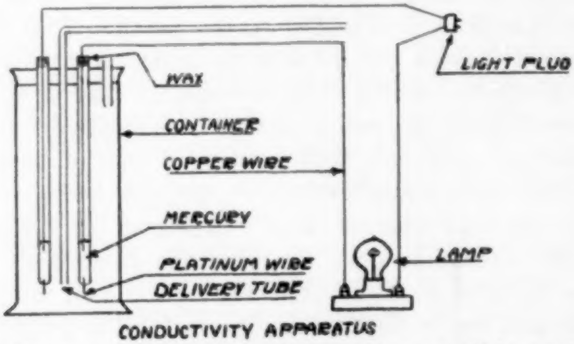
SOME USES OF A CONDUCTIVITY CELL.

By G. T. Franklin,

Lane Technical High School, Chicago.

The study of chemical reactions that may be carried to an end in solution is easily made by the pupil in the laboratory. The formation of a precipitate or a gas is sufficient in most cases. An indicator readily identifies the end of a neutralization reaction. In most of these cases, however, ions remain in solution due to the presence of a soluble salt. A few cases may be demonstrated involving the removal of all ions. The reader doubtless thinks immediately of reactions between an alkaline earth base and sulphuric or carbonic acid. A conductivity cell may be used to demonstrate this type of reaction.

If there is not at hand a suitable cell, one may be readily improvised by the teacher, or a pupil may be detailed to do it as an interesting project. The writer has made one which serves the purpose very well by taking an old 500cc graduate and cutting it to the desired height. The diagram is self-explanatory. Two short pieces of platinum wire, a little mercury, a little glass tubing, a lamp rheostat or a block of wood with lamp base, and electric light cord are sufficient for the purpose. Care must be taken to have the platinum wire extend through the glass and in contact with the mercury. To prevent loss of mercury, the copper wires may be sealed at the top of the glass tube with wax. Two lamps, one very low in current consumption and one as large as one hundred watts, are needed.



CONDUCTIVITY APPARATUS

Some limewater is added to the cell, a small lamp inserted and the current turned on. The lamp glows brightly. Car-

bon dioxide is passed through the solution rather slowly. Of course the class should be made familiar with the reaction between water and carbon dioxide before the beginning of the experiment. As the reaction proceeds the lamp glows dimmer and later goes out completely. If an indicator is used, it will be noted that the lamp ceases to glow at the time the indiactor shows the end point is reached. If the action is now continued, the precipitate slowly dissolves and the lamp glows again. Each fact is a stimulus for numerous discussions. The formation of an acid salt, solubilities of calcium carbonate and calcium bicarbonate, carbonic acid as a weak acid, and other related facts may be further demonstrated and discussed. The formulation of the reaction

$$Ca^{++}+\overline{\overline{CO_3}}+2H^{+}+2O\overline{H} \rightarrow CaCO_3+2H_2O$$

provides activity for the class.

The experiment may be repeated using barium hydroxide and carbonic acid, or barium hydroxide and sulphuric acid. If the latter is used, the acid should be rather dilute, or else the end point may be passed without affecting the lamp.

Acetic acid may be used as an example of an acid that is rather weak and ammonium hydroxide an example of a soluble weak base. If glacial acetic acid is used, the lamp does not glow when the current is turned on. Water is slowly added and presently the lamp glows feebly. If the small lamp is replaced by a large one, there is no glow. The acetic acid is now replaced by hydrochloric acid, or if the teacher thinks no confusion will result, a drop or two of hydrochloric acid is added to the acetic. The brilliant light obtained from the large lamp makes a striking comparison of the two acids. The experiment may be repeated, using ammonium hydroxide and potassium hydroxide. To show that all salts are well ionized, a salt of acetic acid and one of ammonium hydroxide may be used.

The pupil may wonder why a solution of sodium or potassium hydroxide does not give the same glow in the lamp as an acid of equal concentration. The mobility of the hydrogen ion is discussed. To clarify the matter, some hydrochloric acid is added to the cell with indicator. Potassium hydroxide solution is added very slowly and the glow

of the lamp noted at the end point. This gives a qualitative demonstration of an effect, which is obtained by carefully plotting the conductivity of the solution as the base is added. A sharp turn in the curve at the end point is obtained.

SPARK RECORDING OF LISSAJOUS' FIGURES IN THE ELEMENTARY PHYSICS LABORATORY.

BY R. L. EDWARDS,
Miami University, Oxford, Ohio.

The combining of two simple harmonic motions at right angles by means of the sand pendulum is one of the most interesting experiments in elementary mechanics. The method, however, is subject to a number of disadvantages, among which may be mentioned the following: (1) The sand does not produce a permanently recorded figure, and the figure is necessarily so large on account of the great width of the line in sand that it cannot be traced in a notebook without reduction in size, using for example a pantograph. (2) It is difficult to locate the center of gravity of the bob for measuring the relative pendulum lengths, and as the sand flows out, the center of gravity changes; also because of the large amplitude, the actual motion is not harmonic; as a result even under the best conditions retracing is poor. (3) Not infrequently the aperture becomes clogged during a tracing, or there is inaccuracy in starting the pendulum to swing. This involves sweeping away the sand for a fresh start. In any case there is considerable scattering of sand. (4) Unless an assistant stands over the student, he can not know how good technique he uses or indeed whether the student actually obtains experimentally all the assigned figures.

In the present practice of the physics department of Miami University all of these disadvantages are eliminated by the use of spark recording. The bob used is a lead sphere three-fourths of an inch in diameter, through the center of which a short No. 20 copper wire passes, serving as a tracing point at one end and support at the other. A pair of No. 32 copper wires swing the bob from a dry wood horizontal bar at a fixed height of about 150 centimeters

from the table. A wire clip which can be slid along as desired holds the wires together and controls the length-ratio for any required ratio of periods. An adjusting rod in the wooden bar on which excess length of the wire is wound controls the height of the bob in each case so that the pointer is about five millimeters above the metal base. A small induction coil and a roll of two-inch test paper[1] completes the required equipment. When the pendulum is properly swinging, a key in the primary of the induction coil circuit is closed, and a permanent record of the path of the pendulum obtained.

After a few trials, the average student is able to obtain uniformly good figures, since he may critically and deliberately observe the motion of the bob before closing the circuit. On account of the considerable length of the pendulum, and its small amplitude of swing, the bob vibrates twenty or thirty times before appreciably deviating from its initial course—assuming the pendulum length-ratio to be accurately measured.

Finally, spark recording[2] has added very considerably to the student interest in the mechanical experiments of this laboratory.

---

[1]Obtainable from the scientific supply houses at three cents a yard.

[2]Another interesting application of spark recording at Miami is in determining the angular velocity of the earth with the Foucault Pendulum. Three traces of the pendulum path are made at intervals of about an hour. For other uses of spark recording, as the timing of short intervals, see "The Application of Spark Recording to Experiments in Mechanics," Paul E. Klopsteg, J. O. S. A. & R. S. I., November, 1929.

BLACK ANTS CALLED HEROIC FIRE-FIGHTERS.

Big black ants are among the world's most expert fire-fighters, is the conclusion of Ranger F. S. Garl, of Yosemite National Park. Ranger Garl believes that human beings might find it worthwhile to study the tactics of the ants.

Describing one blaze, caused by a lighted match near a big black ant hill, Ranger Garl said that about 50 ants started promptly for the fire and jumped right into it, kicking and biting. Meanwhile other ants kept on with their work.

Then a lighted cigarette was thrown near the match, and a larger force of ants hastened to the scene and destroyed the cigarette. Some of the heroic little firemen were burned to death, or so badly burned that others killed them. But for every ant disabled, another took its place. After the fire was out, other ants were sent to pick up the fallen.

Throughout the emergency, lasting half an hour, the fire was fought in the most orderly manner, attesting to a highly efficient organization, Ranger Garl said.—*Science Service.*

LIGHT RAY REPRODUCTION OF SOUND*

By A. H. Gould,
Boys' Technical High School, Milwaukee, Wis.

The theatres of today are equipped to produce sound pictures by two general methods that are very much different. One method employs a phonograph record geared up to the film and the other makes use of a film upon which both the sound and the scenes are photographed. It is with the latter system that we are concerned.

Have you observed in the case of a talking film that the horizontal dimension of the picture on the screen has been shortened? This is due to the fact that a portion of it has been reserved for the photographic record of the sound although the film still remains standard width. This strip, known as the sound track, runs continuously down the film just to one side of the pictures and has a width of from 80 to 100 mils depending upon the make of recording equipment. The frame of the projector has been moved in to hide the picture of the sound track from the audience.

In the beginning of the process, two cameras are set up on the picture lot, one for sound recording and one for picture recording. These two may be combined in one machine but usually two men are employed, each an expert in his own line. If the two types of camera are used separately, they are run by motors which are electrically interlocked and driven from a common distributor so that they keep exactly in step as if a common shaft were used and synchronism of sound and picture is maintained.

At present there are only three big corporations which make sound recording cameras and light ray reproduction equipment for the theatre. One of these sound recording cameras uses a camera shutter of unconventional design which is capable of responding to the most feeble of microphone currents. As shown in figure 1, it has a duralumin tape formed into a loop with a strong magnetic field flowing at right angles to the plane of the loop. Note the small, slit like aperture behind and between the tapes. A

*Part of the following discussion and the demonstration apparatus referred to were presented by two boys from the physics department to the Boys' Technical High School of Milwaukee as a part of a commencement program. Credit for the development of the apparatus for this is due the Central Scientific Company of Chicago who very kindly offered to take this work off our hands and loaned us the apparatus for the occasion. We have since purchased practically all the outfit.

short ribbon filament of an incandescent lamp is focused so that its image falls upon the film just behind the aperture to form a bright line one thousandth of an inch wide and one tenth inch long. The voice currents from the microphone circuit enter the metal tape shutter as alternating current after passing through the transformers.

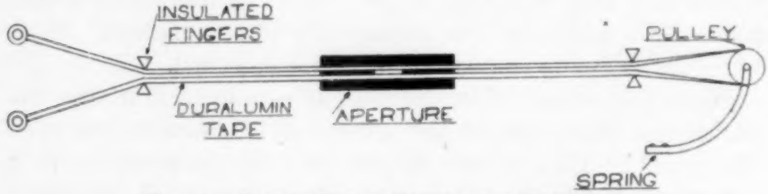


FIG. 1. SOUND TRACK RECORDING SHUTTER.

Now, applying the left hand rule for motor action, you will see that, with the current through the tape in one direction the aperture will be screened by the movement of the tape and with the current in the opposite direction the tape will permit the maximum light flux to pass through the aperture. The amount of opening or closing will depend upon the current strength, one milliwatt of a.c. power being sufficient to operate it at maximum. For theoretical reasons the tape is adjusted to have a natural frequency of 7000 vibrations per second. It is evident now, that, with the voice currents operating the shutter and the film running down at the standard rate behind the aperture, there will be produced a sound track of the variable density type. Examined under a reading glass, this sort of sound track is seen to be made up of bars of alternately clear and opaque film. The thick bars were made by a low note and the fine ones by a note of high pitch.

Suppose we compute the thickness of the bars in this variable density type of sound track. When the film is moving down past the aperture at the standard rate of 90 feet per minute and a low note of 100 vibrations per second is sounding in the microphone to operate the shutter tape, each sound cycle will occupy .01 of the 18 inches of film motion for that second or .18 inch. Each sound cycle consists of a rarefaction and a condensation and produces a current in the shutter tape first in one direction and then

in the reverse—that is, each sound cycle causes an electrical cycle in the shutter. During the half of the cycle when the tapes remain open there results on the positive sound track a clear bar and during the half when the tape was closed there results a black bar. For the hundred cycle musical note the clear bar and the black bar will each be .09 inch wide. A loud speaker with a range up to 6000 cycles is exceptional so that is the highest pitch note we need consider. Such a note would produce bars one sixtieth as thick as the 100 cycle note or 1.5 mils each. In fig. 1a is shown a strip of variable density sound track magnified 14 times. Recording time for this strip was .025 second.

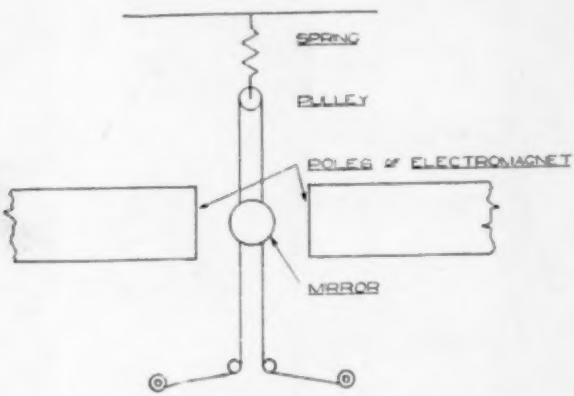


FIG. 2. MOVING COIL TYPE OF OSCILLOGRAPH.

A second method of sound recording uses the oscillograph in making a sound recording camera. Figure 2 shows this old and well known mechanism for tracing the current and voltage waves with which you are all familiar. Essentially it consists of a loop of wire placed in a magnetic field which flows parallel with the plane of the loop so that current variations in the loop cause it to twist. A beam of light is reflected from the mirror upon a slit aperture with the film running down behind it. With the voice currents operating the oscillograph, there will be produced upon the positive film a sound track of the profile type, that portion upon which the beam has made its excursion being clear while that portion of the track not touched by the light is

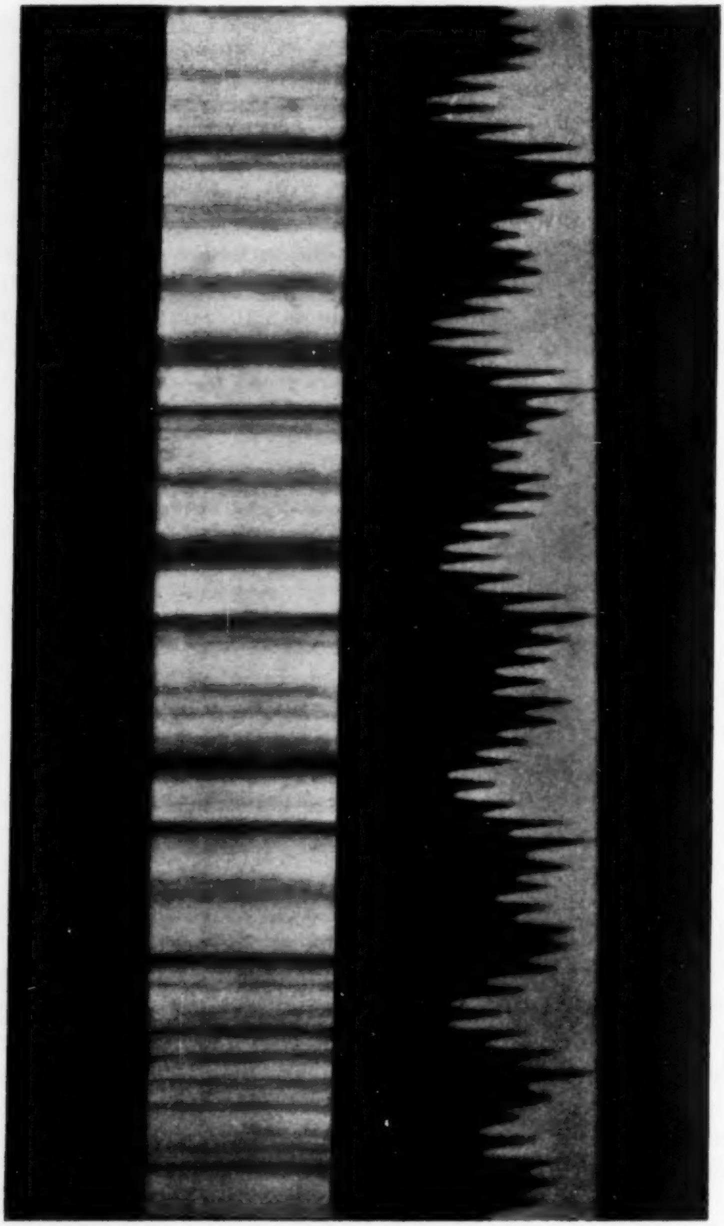


FIG. 1a. PHOTOGRAPH OF THE SOUND TRACK SHOWING THE BARS. (at left.) FIG. 2a. TRACK SHOWING THE FIVE WAVES IN PROFILE. (at right.)

black. Fig. 2a shows a portion of such a track, produced by voice, and magnified 14 times. Recording time was .025 second.

So much for sound recording methods. Now, the negatives having been developed in the dark room from both the picture film and the sound film, the printers can turn out any number of positives having the sound track and the picture combined upon them by double exposure.

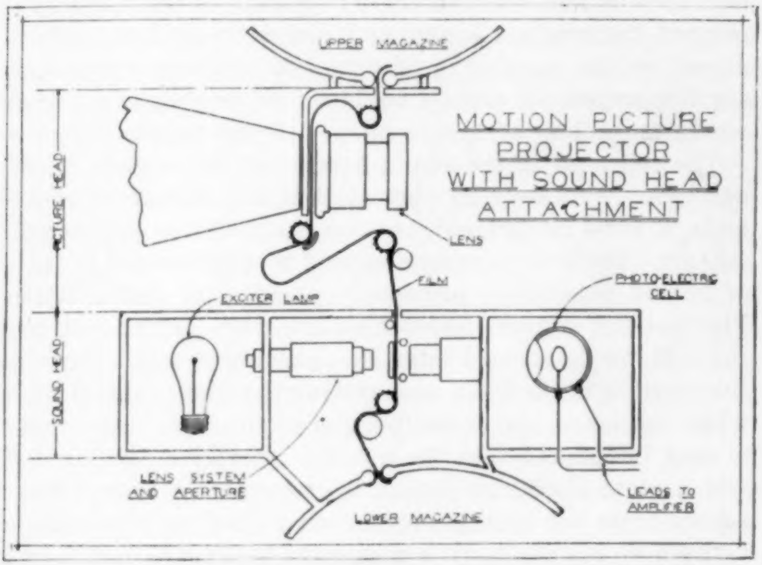


FIG. 3. THE PICTURE PROJECTOR AND SOUND HEAD.

In order to reproduce the sound in the theatre there is needed a device which will cause the diaphragm of the loud speaker to thrust upon the air in one direction for a black bar and in the opposite direction for a clear bar so that the sound cycle will be reproduced. The old picture projector of the theatre must have, added to it, a sound head which lies just below the picture head as shown in figure 3. This sound head contains an exciter lamp, lens system and photoelectric cell. The exciter lamp is an incandescent lamp with a short ribbon filament parallel to the bars of the sound track and heated to the maximum temperature. To the right of this is a lens system with the aperture enclosed in it to throw upon the sound track a razor sharp image of the exciter lamp's filament. This image must not be over one

mil thick or the bars of the high notes will not be able to cut off the light ray.

The film moves down through the sound head with a steady motion and the bars of the sound track interrupt the light ray so that the window of the photoelectric cell receives pulses of light flux. Because the motion of the film through the picture head is intermittent, while that through the sound head is steady, there is needed a 14.5 inch loop of film between the two gates. When the film is printed the original sound and picture negatives are displaced by this amount to prevent loss of synchronism during the projection, since a variation of two picture frames would make loss of synchronism evident to the audience.

The cell used in the sound head is of the central anode, gas type. Processes in photoelectric cell manufacture are quite diverse at present but we may outline one simple scheme. The bulb is evacuated and then connected to tubes of heated potassium, previously purified by redistillation. The metallic vapors condense on the walls of the bulb and the window is formed later by applying a small flame to this portion of the bulb, evaporating the film of metal there which settles on the colder portion of the glass. Hydrogen is next introduced into the cell, the interior is illuminated, and a glow discharge passed by means of a high voltage source from the central ring anode to the metallic wall or cathode of the cell until a maximum current is noted on a galvanometer. The hydrogen is then thoroughly removed and a small quantity of purified argon introduced to give correct gas pressure.

Manufacturers are not able at this early stage of the process to turn out matched tubes as is done in radio tube making and every tube will have its own characteristics. All are alike however, in one respect, that, with a voltage applied to the cell, and light flux striking its interior, electrons are released from the potassium hydride lining and start toward the central anode setting up ionization currents by collision and this current across the gas space is always strictly proportional to the light flux entering the window of the cell. This strict proportionality holds from the most feeble of rays to the most powerful. It is this straight line relation that makes the gas filled tube so valuable in sound reproduction.

This gas cell has a critical point where a sustained glow takes place if either the light flux or the voltage is pushed too high. To protect the tube a high resistance of about 2 megohms should be placed in series with it. If care is taken to prevent an undue amount of sustained glowing the tube should have an almost unlimited life. Constant emission from the heated filament of the radio tube limits the life of such a device but we have here a cold tube with only two high tension electrodes.

Now that we have noted the several parts of the sound head let us see how it functions. The moving sound track causes the ray of light from the exciter lamp to pulse upon the photoelectric cell. The B battery or B eliminator voltage is able to drive a current across the gas space of the cell only when the light ray falls upon the cell. Hence we have an electrical valve which is operated by a light ray or a device which changes light pulsations into electrical pulsations. These electrical pulsations are fed into a six stage audio amplifier similar to that in any radio receiver, and the energy of the impulses built up to a point where they are able to operate six to twelve dynamic loud speakers. The output energy from the photoelectric cell may be in the neighborhood of 2 microwatts which would be boosted in the amplifier to about 20 watts. With speakers of 20% efficiency, 4 watts of sound energy would get out into the air and this energy is considered sufficient for a large theatre.

When the sound track is being recorded in the studio the sound recorder may monitor his work or vary the volume of the recording and listen in to its reproduction, using a system similar to that in the theatre but having the photoelectric cell of the reproducer operated by a part of the beam that passes through the translucent film. He is usually located far enough away from the actors so that their voices are not directly audible to him. The final result may not be what he hears during the monitoring since various factors in development of the film and in the final projection affect his work.

Figure 4 shows the demonstration outfit for the production of sound by an interrupted light ray. It works well, is large enough to be visible over a large hall and produces

very pure, musical notes with considerable volume on our three foot cone speaker. It lends itself well to sound demonstration work in physics. At the right of the picture is shown the 400 watt projector made to throw a narrow, vertical beam of light which is focused upon an erect slit aperture. To the left of this is a perforated siren disc driven by a variable speed motor mounted on a heavy tripod.

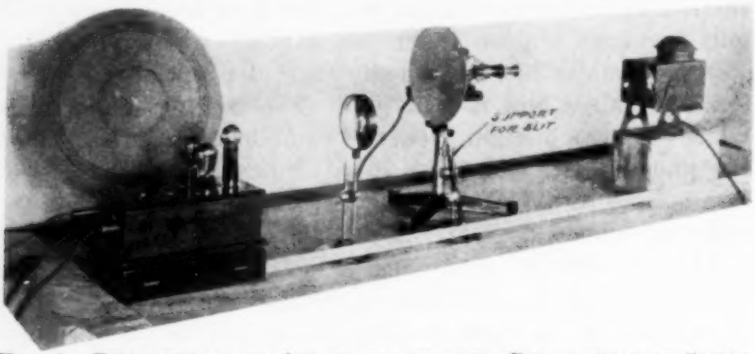


FIG. 4. DEMONSTRATION APPARATUS FOR THE PRODUCTION OF SOUND BY AN INTERRUPTED LIGHT RAY. BY COURTESY OF THE CENTRAL SCIENTIFIC CO.

Three rows of holes in the disc are so related as to give the major triad when used together. Using a card with a slit aperture held horizontally to the left of the disc, a single note can be obtained from any one circle of holes. A lens of about 20 cm. focal length bends all three rays upon the window of the photoelectric cell. The photoelectric cell hook-up and two stage audio amplifier are combined in a single case. Mounted on top this case can be seen the cell with the two 201A amplifier tubes to the left of it. The same case contains a step down transformer for the filaments of these tubes so that an A battery can be dispensed with if 110 volt pressure at 60 cycles is available. An output transformer protects the loud speaker from any excessive plate voltages.

The necessary B and C voltages may be obtained from B batteries or from a B eliminator. It might be well to have the pressure on the photoelectric cell variable as it may be worked fairly close to the critical point and this varies with different cells and the light flux received. In experimenting with the same approximate light flux on the cell's window

as we used you might start with 100 volts and push it slowly toward 200 volts, keeping watch that you do not crowd it beyond the point of sustained glow. At each increase you might cup your hand over the window of the cell to shut out the light and look inside to make sure it is still safe.

We are often asked why we cannot run a talking film in this demonstration outfit. Our optical system and aperture would have to be very elaborate to produce the necessary razor sharp ray of light on the sound track and our cell far more sensitive than this one. In fact, the cell used in the theatre costs about 20 times as much as ours.

Another question is concerning the current across the gas of the cell. This is probably a few microamperes in this cell at maximum and a milliammeter shows no deflection at all.

THE SECTIONING PROBLEM IN GENERAL CHEMISTRY.

BY A. J. CURRIER.

Examinations designed to test previous training in high-school chemistry and aptitude for the study of chemistry were given in September 1929 to freshmen matriculated in four technical schools (Agriculture, Chemistry and Physics, Engineering, Mineral Industries) of The Pennsylvania State College. Data from these examinations were used to show the status of the training in high-school chemistry and in arranging "A" sections in general chemistry given in the first semester. The results of these examinations were compared with the results obtained at the completion of the course of the first semester. The work will be continued.

The four conclusions drawn from the study are as follows:

(1) Of the students who entered four technical schools of The Pennsylvania State College in 1929, those in the School of Chemistry and Physics ranked the highest in the relative percentage who had high-school chemistry. Students in the School of Engineering ranked second, in the School of Mineral Industries third, and fourth in the School of Agriculture.

(2) The number of failures in general chemistry in college is three times as great (39%: 13%) among those who did not have high-school chemistry as among those who did have it. In the "A" sections this ratio is even more striking (35%:5%). It follows that the student who had studied chemistry in high school had a decided advantage over the one who did not.

(3) Results obtained in the training tests formed a sound basis for the selection of students for "A" sections.

(4) Results obtained in the aptitude tests did not form a sound basis for the selection of students for "A" sections (excepting those with very high grades—90% or above—in these tests).

THE INFORMATIONAL OUTLINE AS A PART OF THE NEWER EXAMINATION IN BIOLOGY.

BY R. A. STUDHALTER,
Texas Technological College, Lubbock, Texas.

With most types of the newer examination, the student is given little or no opportunity to organize an answer involving a more or less comprehensive bit of subject matter. To overcome this objection, it has been the practice of the writer for the past seven or eight years to include as a part of his examinations one or two sections involving an informational outline. This has been used to supplement the completion test, multiple choice, true-false statements, labelling of mimeographed drawings, etc.

By the term "informational outline" is meant the organization of an answer in the form of an outline, the major subdivisions of which are the usual topical headings, the minor subdivisions being longer phrases or complete sentences giving a more complete body of information. The student is taught during the course to prepare such outlines, both in lecture and in laboratory work. An example on photosynthesis follows.

I. *What photosynthesis is:*
   1. Formation of sugar from carbon dioxide and water by chlorophyll in presence of light.
   2. Takes place in any green part of plant.

II. *Materials used and their sources:*
   1. Carbon dioxide:
      a. Colorless, odorless, tasteless gas.
      b. Constitutes about 0.03 percent of the gases of the atmosphere.
      c. Enters leaves through stomata.
      d. Through intercellular spaces.
      e. To mesophyll cells:
      (1) Dissolves in water on cell wall.
      (2) By diffusion and osmosis to cytoplasm.
      (3) To chloroplasts.
   2. Water:
      a. Absorbed from soil by root hairs.
      b. Transported through roots and stems to leaves.
      c. From vascular bundles in veins to mesophyll cells.
      d. To chloroplasts within mesophyll cells.

III. *The process of photosynthesis:*
   1. Etc.

The informational outline is used on the examination in two ways. First, the student is asked to prepare his own outline, as indicated in the following sample questions:

Prepare an informational outline on the physical and chemical nature of protoplasm.

Discuss, by means of an informational outline, the topic of transpiration.

Second, the outline headings are given to the student on a mimeographed sheet, and the student is expected to fill in the actual information desired. Space for the student's notes is left on the examination sheet. An example of this is given below:

Complete the following informational outline on the metabolism of starch.

I. *In the mouth:*
  1. Mechanical factor—
  2. Enzyme and its action:
    a. Name—
    b. Source—
    c. Action—

II. *In the stomach:*
  1. Mechanical factor—
  2. Action of the enzyme from the mouth—
  3. New carbohydrate-digesting enzyme from the stomach—

III. *In the small intestine:*
  1. Mechanical factors:
    a.
    b.
  2. Enzyme from pancreas and its action:
    a.
    b.
    c.
  3. Bile action on starch—
  4. Enzyme from wall of small intestine:
    a. Name—
    b. Action—

IV. *Absorption:*
  1. Absorbed in the form of—

V. *Circulation of absorbed materials:*
  1. Transported by blood or lymph?—
  2. Pathway over which transported—
  3. Transported to—
  4. Stored there in the form of—
  5. When again needed, reconverted into—

VI. *Ultimate use of the product of starch digestion:*
  1. Kind of cells in which the product is mostly used—
  2. Other cells in which it is used—
  3. During use, the product is combined with—
  4. This process is called—
  5. The chemical substances formed during the process named in 4 are:
    a.
    b.
  6. Besides the formation of these chemical substances, the following is released—
  7. Use to the body of the latter—

VII. *Places of excretion of the chemical products of the decomposition of starch:*
  1.
  2.

The informational outline has many of the advantages of the other newer examination types, such as yielding

more information in less time, involving less actual writing and more thinking on the part of the student, and ease of grading. In its second form above it may be looked upon as a modification of the completion test, but it has the advantage of presenting a larger body of coordinated information in a well organized form. This demand on the organizing ability of the student is the most pronounced advantage of the informational outline, and in this respect it has most of the good points of the essay type of examination.

HUMANIZING SCIENCE TEACHING*.

By L. E. Hildebrand,

New Trier Township High School, Winnetka, Ill.

There are two outstanding types of poor teaching done by two types of teachers:

1. The first is a "teacher" who has little or no interest in either subject or in the student. This is of course the lowest form of teaching which does probably more harm than good, much like disinterested hired help in business who can run your trade "in the ground" in very short time. In education as in business, salesmanship is the essential quality that puts the thing over, in other words *education as well as goods must be sold by creating a desire to possess it.*

What a teacher of this type can do to a school is well illustrated by the following incident which came under my own observation some years ago in Pike County, Indiana, in a country school house of the little red variety "on the hillside in the woods." For three years an enthusiastic teacher taught the school and in that time the interest of the community increased so remarkably that every available bit of space in the room was occupied by seats and chairs and the school was a beehive of life and industry. After the third year this teacher was promoted to the principalship of the schools of one of the smaller towns in the county and a new teacher came to teach the little school on the hillside. Now a great change set in; by the middle of the year the enrollment was exactly half of the other teacher's number the year before and by the end of the year

*Reprinted from the Transactions of the Illinois State Academy of Science, Vol. XX. Published March, 1928.

she had about one third as many. Of course this was before compulsory attendance was in force but suppose it had been since the day of truancy laws what would have happened then? Beyond a doubt it would have been little better for the Community, because the majority would have attended under protest and their taste for education would have turned to nausea; and antagonism to the teacher would have made out of that room a place of contention and discontent.

I was personally much interested in this case because some of my own friends and acquaintances attended there and so I visited there one day and here is what I saw: The teacher, a young lady, sitting behind a small table, appeared half asleep, almost sullen in all her questions and remarks to the children, entirely without enthusiasm, no circumstance could seemingly induce her to smile and all in all she cast such a gloom over those children it gave one the impression she was dealing with two great evils, namely, the children and the curriculum of studies, that life was not worth living and the brats under her instruction were the worst ever wished on to any teacher since the profession was invented.

2. The second kind of poor teaching is caused by an over-estimation of the importance of the subject and a lack of interest in the student. Such a teacher will invariably dehumanize his teaching by regarding the learner as a sort of necessary evil in order that an opportunity may be found to teach *all* the important facts of the subject exactly as they appear to his own mature mind. He disregards the ability of the student to understand and fails to awaken an interest by giving the student some points of contact with his life's experiences and interests. Such a teacher is always a driver and never a leader of the young minds under his training.

Now for two types of good teaching:

1. The highest type is that accomplished by a teacher who is interested in both his subject and the students. Such a teacher naturally senses the nature of every student individually and tries to connect up the subject with some human interest so that even the slowest ones can find it interesting to know something about it. This is

the teacher who knows that a spark of interest must be kindled before the mind can have a desire to learn for in learning as in eating there must be a desire to partake or it simply will not happen. This teacher is essentially a leader instead of a driver *and blessed is he who can lead and need not drive.*

2. Another kind of good teaching is often accomplished by a teacher who has the proper human sympathies although he may not have a first class knowledge of the subject to be taught. Such a teacher will, however, for the sake of the students, feel the responsibility to prepare the work well enough to achieve real results.

Now in conclusion. How can teaching be humanized? It is, of course, easier said than done otherwise we could all do it and the teaching of Science would be like a picnic on a fine day or life at the edge of Paradise. The main point I believe is that cold isolated facts can be vitalized as a rule by connecting them up with some well known human interests as for instance in Chemistry the study of carbon or nitrogen and their compounds in relation to foods, poisons, plant growth, explosives, etc. In Biology the study of a fish or frogs, even their anatomy, can be related to human life both economically and structurally; their value to man is evident enough to the student and their structure is very much like that of our own bodies in many particulars and then their actions are really wonderfully like our own in response to stimuli upon the different senses.

Finally, what is teaching after all? I think we must agree that while some facts of knowledge must be imparted it is of far greater importance to arouse life interests which will remain and cause the learner to gather up *more* knowledge along the entire way of life.

TOY BALLOONS FILLED WITH HELIUM.

Children's toy balloons, in many cities, are today freer from the danger of explosion than the big foreign airships. Like the American Los Angeles, they are now filled with helium. Formerly they were filled with hydrogen, or even illuminating gas, but because of the fire danger, and many accidents that resulted, a number of cities passed ordinances forbidding the use of inflammable gases. Then balloons were made filled with air, but of course, they would not go up. When helium became available commercially, it was used for the purpose, and now baby can have his balloon, with no danger that it will explode in his face if papa gets his cigar too close.

UNITS OF MASS AND FORCE.

BY GWILYM E. OWEN,
Antioch College, Yellow Springs, Ohio.

I have been asked by more than one teacher of physics, "What is a slug?" The word slug is common enough in the literature of physics and engineering to be familiar to every teacher of these subjects, and it has enough merit to justify its more common use. The slug is the unit of mass in the English gravitational system, and is the mass of a body which would get an acceleration of one foot per second per second under the action of an unbalanced force of one pound; it is therefore equal to a mass of 32.2 pounds.

It seems inconsistent that we use different names for the units of force and mass in the two absolute systems, (dyne and gram, poundal and pound) while in the gravitational systems, we have names (pound and gram) for the unit of force, but the unit of mass seems to be nameless or at least its name is not used. After showing that F = kma is a mathematical statement of Newton's second law of motion our process of reasoning is something like this: —(k) is a constant proportionality whose value depends on the units in which (F), (m), and (a) are measured. The metric unit of acceleration is one cm per second per second, but what are the units of force and mass? They are still to be defined. Then we can define them in such a way as to make (k) be anything we please. We will choose to ket k=1 and define the units of force and mass so that f=ma. As we have two things to define, we can define one of them arbitrarily and then define the other so that the equation holds. In the metric absolute system, the unit of mass is arbitrarily defined as the gram, one thousandth part of the mass of a given piece of platinum, the standard kilogram. Then we must use a unit of force such that when the mass is expressed in grams and the acceleration in cm per sec per sec, the equation F=ma will hold. Let us consider a mass of one gram falling freely under the action of gravity. Its mass is one gram; its acceleration is 980 cm per sec per sec; the force acting on it must therefore be 1x980 units, but not 980 grams force. Those units must have a name, so

they are called dynes. We do exactly the same thing in the English absolute system and end up with the conclusion that the force acting on a one pound mass when it falls freely under the action of gravity (that is its weight) is 32.2 units, but as the units are not pounds, we give them the name poundals. These two systems are called the absolute systems because the arbitrarily defined quantity, the fundamental quantity, is the unit of mass.

In the gravitational systems the unit of force is arbitrarily defined, in the English gravitational system it is the force with which the earth attracts a given piece of platinum at Greenwich near London and is called a pound force or a pound weight. As the force of gravity is not the same everywhere on the earth's surface, the place of measurement must be specified. Now suppose we take such a body, one which the earth attracts with a force of one pound, and let it fall freely under the action of its weight. Its acceleration will be 32.2 ft per sec per sec. Then its mass, given by the equation $F=ma$ is $m=F/a$ or $1/32.2$ units. But these units are not pounds. In order that we may talk about this unit of mass we must give it a name and it is called a slug. It is just as important to give this a name as it is to name the unit of force in the metric absolute system. It is well for the student to make a table showing the units of force and mass in all four systems and to remember that he should use the units of one system throughout a given problem.

Of course the absolute system of units appeals to the scientist because the fundamental unit is the unit of mass, whose value does not depend on the place where the measurement is made. However, in teaching physics to students, most of whom will not be scientists, it may be well to keep in mind, that the average man has need for units of force much more frequently than for units of mass. Of the English systems, then, the gravitational is the more useful. It is much better for the engineer, for instance, to have his force come out in pounds than in the more unfamiliar poundals. The slug is the unit of mass which he should use, then, whether he calls it by name or not.

CHANGING IDEALS IN MATHEMATICAL INSTRUCTION.

By Myron O. Tripp,
Wittenberg College, Springfield, Ohio.

In this article an attempt will be made to compare ideals and methods of teaching twenty-five to thirty-five years ago with those in vogue since the Great War. During the last third of a century great changes in the general educational aims in this country have been brought about—some producing highly beneficial results and others productive of results that may well be questioned. The spirit of democracy in education, which at first seemed to involve mainly the elementary school, has been extended to the public high school; just now that same spirit is invading our colleges. The recent development of public junior colleges in many states attests the importance of education for the masses. In this scheme of mass education it is natural to expect sweeping changes in mathematical instruction.

Forty years ago students of the old Robinson's Progressive Higher Arithmetic learned numerous tables of denominate numbers, many of which are now entirely out-of-date; even then, some of them had little reason for being taught. There was too much of a tendency to make a treatise on arithmetic an encyclopedic affair, and insufficient regard for the ability and needs of the learner was common. Students in district schools were made to learn that 2 hogsheads = 1 pipe, and 2 pipes = 1 tun. Just why a student in elementary schools should memorize that a beer gallon equals 282 cubic inches is hard to understand. In the back of the old Robinson's text there was a chapter on alligation, sometimes wrestled with by bright students in an attempt to learn the arithmetical aspects of mixing drinks. Fortunately our most recent texts have broken away from arithmetic of this type, and students are now learning only those tables for which the average high grade citizen may sometime find use in the course of his life experiences.

One of the most important changes, so far as high school instruction is concerned, is the use of the graph. In the algebras of the nineties practically nothing was done in the way of graphic representation of equations.

Text book writers of that period hesitated about including graphs for fear the books would not sell. Then, too, there were very few high school teachers willing to undertake the teaching of such a subject. Even today there are students entering college who have never studied graphs, simply because their teachers prefer to pass over the subject. This change should be considered as an important step forward in mathematical instruction. At present there is practically no excuse for the teacher to omit graphs, since the student should receive this training whether he goes to college or not. This correspondence between the geometry of graphs and the algebraic treatment of equations makes the graph a most helpful pedagogical tool in algebraic work. The graph gives concreteness to the alegebraic solution and also serves as a check. Equivalent equations may be greatly amplified by resorting to graphic treatment.

The great stress laid upon the teaching of commercial work has reacted upon mathematics. In high school instruction it has greatly changed the character of text book problems, while in college a new course is now added under the title "Mathematics of Finance" based upon geometric series and logarithms. High school teachers should accordingly keep in mind that geometric progression is not a curiosity, but an intensely practical topic where problems of compound interest are involved. It should be added that compound interest is of basic importance in a discussion of annuities, amortization of debts, sinking funds, bond evaluations, life insurance, and many other phases of business administration. The unusual interest of a large part of our wage earners in the question of investments in stocks and bonds, and other securities, is having a decided influence upon our mathematical work, and it is the business of the progressive teacher to adjust his work to meet these new demands.

The connection between arithmetic and algebra is now being emphasized far more than it was a few decades ago. Formerly there was a very abrupt change in passing from concrete arithmetic work to the abstract work of algebra. Now we are making the transition more gradual by using formulae in the arithmetic of the

seventh and eighth grades, and after algebra is begun, we are continually substituting numbers for letters so as to emphasize the idea that algebra is generalized arithmetic. Work of this type has a tendency to prevent mere juggling of algebraic symbols.

There is one respect in which the schools of today are decidedly inferior to the schools of a third of a century ago, and that is in numerical computation. It seems to be impossible for teachers to get the amount of arithmetical drill work done that was formerly attempted. One reason for spending less time on arithmetic in the elementary school has arisen from the enrichment of the curriculum. It is obvious that if we are to teach more subjects, some of the old line subjects must receive less attention. We now hear much talk about teaching minimum essentials in arithmetic—something not usually considered forty years ago. The introduction of computing machines in business practice has naturally made the teacher feel that some of the old time drill may well be dispensed with. However, there seems to be a danger of running to an extreme in omitting drill work. In such a topic as fractions drill work should be emphasized much more than at present in order to make sure that fundamental principles are mastered. Our teachers quite commonly do not teach the fundamental principles of the least common denominator by the factoring method. Students should occasionally be drilled in dealing with fractions whose denominators are large so that, after due allowance for shrinkage is made, the pupil will still have a fair working knowledge. There is, of course, no argument in favor of using the Euclidean Method of finding the greatest common divisor in the elementary or secondary school, for the underlying principles are far too difficult for the students' power of comprehension.

The spirit of democracy in education has had a strong tendency to fill our public high schools with students not formerly considered as having the proper intellectual foundation. There has been great pressure upon the teacher to get along somehow with these students without labeling them as failures, and as a result, thoroughness in the study of fundamental principles has not al-

ways been insisted upon. Mathematics has probably suffered more than other subjects in this respect, because of the logical sequence of topics studied. Fractions in algebra can scarcely be mastered when the student is not well grounded in the corresponding arithmetical work. In college work the difficulty is felt very keenly, for there we frequently have the double trouble of lack of preparation in both the elementary and secondary fields. In fact, the college professor is now obliged, during the freshman year, to spend a large part of his time and energy in reviewing what the student is supposed to have learned in the high school. Formerly college students were looked upon as persons having intellectual interests of a high grade, but now conditions are changing and we hear much talk about the convention of going to college. When one objects to the low calibre of many students now entering college, the argument is met by an optimist who says that even if the student does not develop much intellectual capacity in his four college years, he gets a type of civilization that is well worth the time and money spent. We frequently hear it said that college furnishes a man certain contacts that are of great value in after life, it being understood that these contacts are not with books or with college instructors, but rather with fellow students in the fraternities, the dances, at the stadium, or in some other social or recreational way. While it is true that the habits formed during the very impressionable years of college life are very valuable, it should be kept in mind that these social or recreational habits are not of very much value as a foundation for serious mathematical study. Apparently in our present life of leisure and pleasure-seeking, we are not developing that type of thinking that may be called reflective, and which is so fundamental to a proper approach to mathematical science.

A TEACHER PROBLEM.

It is the teachers' own problem. Only the teachers can change the status of the teachers of America. No other professional group has the unlimited potential power and influence that the teachers have. They need organization under the leadership of teachers themselves.—*The Atlanta Teacher.*

BACKGROUND AND FOREGROUND OF GENERAL SCIENCE.

By Wm. T. Skilling,

State Teachers' College, San Diego, Calif.

No. XIII. Michelson's Newest Experiment and Its Predecessors.

On a level stretch of country near Santa Ana, in Southern California, is in progress an experiment which bids fair to be a classic of its kind. Here Dr. Michelson and his technician Mr. Pearson, with additional assistance from the near-by Mount Wilson Observatory, are making a new effort to determine the velocity of light.

As is well known, Professor Albert A. Michelson's previous determination of this very fundamental constant of nature is now accepted the world over as the most authoritative value of the velocity of light. Numerically this value, according to Dr. Michelson's 1927 determination is 186,285 miles per second reduced to vacuum. As measured through the mountain atmosphere back of Pasadena it was 41 miles slower than this. Even rare mountain air has a little retarding influence.

This best of all heretofore determined values for the speed of light, though accepted by the scientific world, and thought to be within thirty miles of being correct, is not a value after which its author is yet willing to write the word *finis*. Therefore the veteran experimenter is making a measurement in a very different way from any that he or others have used thus far.

Before describing this latest method of timing a beam of light it will be worth while to go back to the very beginning of man's effort to do this thing which, like many of the measurements of science, would seem at first thought impossible.

Galileo, back at the beginning of the seventeenth century, must be given credit for making the first recorded attempt to measure light speed. To be sure, his attempt was wholly unsuccessful, but he should be remembered for trying. Galileo successfully proved many things by experiment, but whether his experiment succeeded or failed mattered not so much as that he led the world into the experimental method of science study.

Galileo's method of attempting to find whether the passage of a beam of light is, like thought, instantaneous, or like sound, progressive, was carried out as follows: Two men were stationed about a mile apart, each with a light. At night they flashed signals to each other by covering and uncovering their lights. When number one flashed his light number two, a mile away, was to flash his as soon as he saw number one's. If number one could see number two's flash instantly after giving his own signal he would conclude that no time was lost in the passage of light from one place to the other.

At first there seemed to be a little delay in getting the return signal, but by practice the delay was reduced almost to zero.

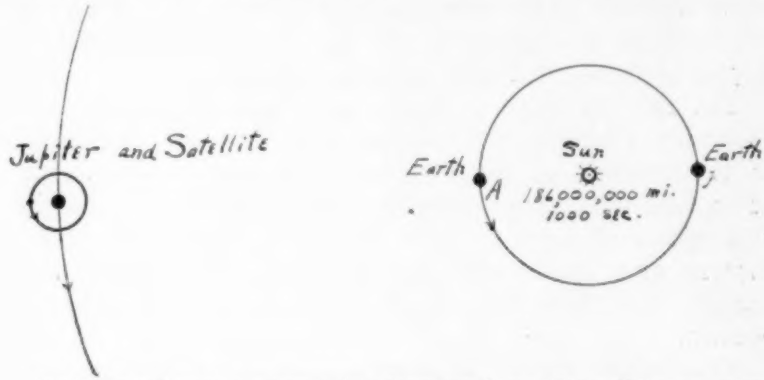
To prove as to whether or not this slight delay could be attributed solely to the time required for the mind and nerves and muscles to act after seeing the flash, Galileo had the two men come near together and repeat the signals. It was found that the same slight delay occurred when the experimenters were close together as when a mile apart. This proved that the time needed (if any) for light to travel that distance was too small to measure. We now know that the time necessary for light to go a mile and back is only $\frac{2}{186{,}000}$ of a second, and it is no wonder that such an infinitesimal period of time was wholly unnoticeable.

The first successful measurement of light was made in 1675 by the astronomer Römer. This and other determinations are given briefly in article No. IV of this series, in the October 1929 issue. Somewhat fuller details than are given there may be of interest.

It should be remembered that Römer had a double duty to perform. He had first to prove that light does not travel instantaneously, and second he had its speed to measure.

Römer was a brilliant young Dane, who was invited by the director of the Paris Observatory to come there for study. While watching one of the four visible moons of Jupiter, he noticed that its eclipses behind the planet, taking place about every 42½ hours, did not occur at perfectly regular intervals. He saw that the eclipses

were several minutes later occurring when the earth was on the opposite side of the sun from Jupiter than when six months before it had been on the side nearest Jupiter. This led him to see that it must take several minutes for light to cross the earth's orbit. (Fig. 1.)



Later and more accurate observations than Römer was able to make have shown that the eclipses at B in the diagram come 16 2-3 minutes (1,000 seconds) later than at A. It is about 186,000,000 miles across the earth's orbit, from A to B, therefore light travels 1-1000 that distance per second, or 186,000 miles.

Much later than Römer, about 1850, two Frenchmen, Fizeau and Foucault, devised laboratory methods of timing light over a comparatively short course. The principle in both these methods is to send jets or flashes of light in rapid succession, reflect the flashes back from a distant mirror, and by a very sensitive timing device determine how long it took the flash to go to the mirror and come back.

Fizeau sent his flashes by letting a light shine through between the cogs of a rapidly turning toothed wheel. His wheel had 720 cogs. If the wheel were allowed to stand still the light reflected from the distant mirror would come back along its track and pass through the same opening between the cogs through which it had gone on starting.

Now if the wheel were started and made to go faster and faster there would come a time when each jet of light, when it returned, would find a cog blocking its

way, and the eye of the observer, watching behind the wheel, would not see the light. Fizeau found that this happened when his toothed wheel had a velocity of 12.6 revolutions per second. Then if the wheel were speeded up until its rate of rotation was doubled, the light would come through to the eye again. Evidently it now found the next space adjacent to the one through which it had departed ready to let it pass through.

The rate of turning being now 25.2 revolutions per second, the length of time that it took an opening to go to the position of the next opening was $\frac{1}{(720 \times 25.2)} = \frac{1}{18,144}$ of a second. The distance the light had gone in this space of time was, in Fizeau's experiment 8,633 meters, or a little more than 10 miles. The velocity per second was therefore something over 181,000 miles a second.

Foucault's method of sending flashes of light was to rapidly revolve a mirror. Each time the face of the mirror passed a certain position with respect to a light off to one side the reflected beam was directed toward another mirror in the distance. In any other position the revolving mirror, if it caught the light at all, would send it somewhere else than to the stationary distant reflector.

While each flash of light from the revolving mirror was engaged in making its round trip to the distant mirror the face from which it came had time to turn a little. Therefore the returning jets of light would be reflected, not to their source, but a little to one side of it.

In this way, knowing the rate of rotation and the angle by which the returning light is deflected, the time it took for it to go and return could be calculated.

The mirror method of timing the flashes of light is much more sensitive than the toothed wheel method so that results can be obtained over a course wholly within a room. Therefore tubes of water or other transparent substances can be used through which to time the velocity.

The velocity thus found for each medium is equal to the reciprocal of the index of refraction. Thus the index of refraction of water is $4/3$, and the velocity found for water as compared with a vacuum is $3/4$.

Before ever the velocity in various media was measured it had been predicted that just those velocities would be found which are the reciprocals of the indexes of refraction. In other words it would seem that the cause of refraction must be just this degree of slowing up in the media through which the light passes.

The Foucault method of measuring the velocity of light was used in the famous Michelson-Morley experiment, which led to the Einstein theory of relativity. This experiment was a measurement of the velocity of light in various directions. It was the thought that since the earth is moving through space around the sun at a velocity of about 18 miles a second, the speed of light should appear to differ when thrown to one side or ahead or behind with respect to our motion through a supposedly stationary ether. No such difference in velocity was found. An explanation was needed and Einstein found it in "relativity."

Coming back to Michelson's latest experiments on the level cow pastures of Santa Ana we find a great tube a mile long and thirty inches in diameter which serves as race track for the light flashes. The object of the tube is to make it possible to have light travel in a vacuum.

The pipe is made of corrugated galvanized iron about an eighth of an inch thick so as to be strong enough to withstand the air pressure from without. A single air-pump operated by an electric motor is capable of exhausting the air to about half an inch of pressure in a few hours. Great pains have been taken to render the joints of the pipe air-tight.

At one end the pipe, which is above ground, enters a temporary laboratory. In this is the revolving mirror. The light to be used in this race against time comes from a very strong arc which is just outside the wall of the laboratory. It enters through a narrow slit. It strikes one face of the mirror and reflects through a little round window of thick glass into the vacuum pipe. By the way, its lessened speed as it goes through this inch or so of glass must be taken into account. The mirror is one solid block of glass with eight flat sides, each about an inch square, silvered. Thus each revolution throws eight

flashes of light into the pipe. Once within the great pipe the light is caught by stationary mirrors, and thrown from one end to the other, back and forth, until it has made five round trips, thus traveling a distance of ten miles. It is then thrown back through the window at which it entered.

Having traveled 10 miles, the flash of light from the whirling mirror must have been gone about $\frac{10}{186,000}$ of a second, and in this length of time, short as it is, the mirror has turned through a certain fraction of a revolution. The direction in which the returning beam of light is reflected shows how much the mirror has turned. Since the speed of the mirror in rotations per second is known, the time required to turn this fraction of a revolution can be computed.

Such an experiment as Dr. Michelson is now performing is of necessity a tedious one because every operation must be of the highest degree of accuracy. But the tube is already constructed, the laboratory built, and some preliminary tests have been made. We may expect final results within a few months.

Later: A mirror of 32 sides has now been made, to replace the one with 8 sides so that the side from which the light flash leaves may be *exactly* replaced by the next adjacent side while the light is traveling the ten miles. An 8-sided mirror would have to be given a dangerous speed to accomplish this.

NEW TREATMENT FOR IVY POISONING.

A new method for treating poisoning from poison ivy or poison oak has just been reported to the American Medical Association by Dr. Paul D. Lamson of this city.

These plants produce their unpleasant effect by means of a poison called toxicodendrol, Dr. Lamson found. Toxicodendrol can be neutralized or made non-poisonous by changing its chemical composition so that the proportion of oxygen is increased. Benzoyl peroxide produces this change and is besides a non-irritating, non-poisonous substance.

When benzoyl peroxide powder is dusted well over the spots affected by poison ivy, and kept in place by a light bandage, the itching disappears in about 15 or 20 minutes and does not return for 8 or 10 hours after a single application. It is not a certain cure in all cases, but it does relieve the itching and prevent further spread of the poison, even where it does not cure, Dr. Lamson reported.—*Science Service.*

AN OUTLINE OF HIGH SCHOOL CALCULUS

By Noah R. Bryan,
Summer Session, University of Maine, Orono, Me.

The course in high school calculus which is briefly outlined in this article is the result of discussions of this type of work in our summer session course in The Teaching of High School Calculus. Approximately all the topics have been tried out in classroom instruction. The key-note to the beginning of this high school course is found in the recommendation of the National Committee on Mathematical Requirements. "Work in the Calculus should be largely graphic . . . the necessary technique should be reduced to a minimum by basing it wholly or mainly on algebraic polynomials, no further study of analytic geometry need be presupposed beyond the plotting of simple graphs." Furthermore, we believe that the future college student will benefit by such a high school course in calculus. Our point of view here is that of Professor Jones, England, who says in the preface of his calculus text for technical students that he hopes that the time will soon come when boys will learn as they grow up the simple ideas of calculus in addition to those of algebra and geometry. It will then not be such a difficult matter to teach adults the calculus necessary for their technical work.

It is both surprising and gratifying to find the extent to which the graph work of analytic geometry necessary for a course in high school calculus has already been developed by the recent text books on secondary mathematics. An examination of these books shows that not only are straight lines and parabolas plotted but a number of them include cubics also. Indeed, it seems only natural that a course in simple calculus should follow. In the outline which follows some of the topics are given at some length to indicate the nature and the simplicity of the course.

An Outline of High School Calculus.

Preface.

This course is to serve as an air-line into the heart of elementary calculus. It will acquaint the learner with the meaning and the use of differentiation and integration. Secondary school algebra and geometry are sufficient foundation for this course.

Part I gives the simplest kind of introduction. Algebraic polynomials are almost the only kind of functions used. The coordinate or analytic geometry necessary is of a very simple type and can readily be grasped without previous training in curve-plotting.

Part II gives a more theoretical introduction. The idea of limits is illustrated. The fundamental rule for finding the derivative is explained and used. A chapter on simple trigonometry is inserted in order that those who have had no training in it may be able to handle those formulas that involve trigonometric functions. It is assumed that the learner understands how to use logarithmic tables. Part II reviews and extends the ideas that have been presented in Part I. A mastery of this course is supposed to qualify the learner to pursue the study of calculus further with little or no aid from a teacher.

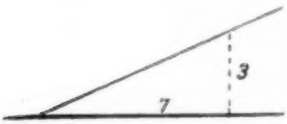
PART I

WHAT IS CALCULUS? We shall not try to give a comprehensive answer here to this question. One must know something of the processes of calculus to understand fairly well what it really is. An illustration or two may give an inkling of some of the uses of calculus. Suppose that we wish to make a box out of a rectangular piece of tin 8 by 15 inches by cutting a square out of each corner and turning up the sides. By means of calculus we can find exactly how big a square we must cut out in order that we may have a box with the greatest volume. This is an illustration from the topic of maxima and minima. Calculus is invaluable in this extensive field of applied mathematics. Calculus as a rate-measurer is another wide application. Suppose that water is running into a tank in the form of a cylinder at the rate of 5 cu. ft. per sec. If the radius of the tank is 2 ft., how fast is the surface of the water rising? By means of calculus the answer may readily be found. Problems involving the finding of surfaces and volumes furnish another wide field of application. Such rules as the area of a circle, πr^2, are easily derived. Many areas and volumes that cannot be found by the ordinary geometric and arithmetic methods may be found by calculus.

ILLUSTRATIONS OF THE MEANING OF THE DERIVATIVE. In arithmetic we often find *average speed.* For example: A train goes 120 miles in $2\frac{1}{2}$ hours. Its average speed is 120 divided by 5/2 or 48 miles per hour. Since the train does not run at a uniform speed, it is likely that its exact speed at any particular point of the distance traveled was either more or less than 48 miles per hour. Our arithmetic method gives us a method of finding the *average speed* but it does not help us to find the exact speed at any particular instant of time. The derivative gives a method of finding the *exact speed* at any particular in-

stant. When used in this way, the derivative is a rate-measurer.

The slope of a line is another illustration of the use of the derivative. First we must have clearly in mind as to what we mean by the slope of a line. When we speak of the slope of a hill in a road, we really mean that the hill rises a certain number of feet vertical for a certain distance of the road if it had continued in a horizontal line. Thus:



The illustration shows that the inclined line has a slope of 3/7. Suppose that we wish to find the slope of an inclined line. Draw any convenient horizontal line through it. From any point in the inclined line, drop a perpendicular to the horizontal line. *The ratio of the perpendicular to the horizontal segment cut off is the slope of the line.* It often happens in our examples that we wish to find the slope of a line that is tangent to a curve at a certain point. The derivative gives a general formula for the slope of the tangent to a curve at any point. Before developing this idea more fully, we must first explain some symbolism and preliminary steps.

PLOTTING. (Omit in case the learner has already had enough training in graph work.)

THE SLOPE-INTERCEPT FORM OF THE STRAIGHT LINE. (In the report of the National Committee it is shown that this function, $y=mx+b$, stands sixth in order of value as preparation for elementary college courses.)

INDEPENDENT AND DEPENDENT VARIABLES. FUNCTION.

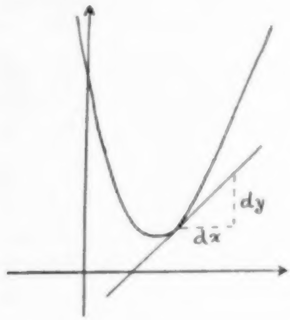
HOW THE FUNCTION NOTATION IS USED.

OTHER WAYS BESIDES F(X) OF REPRESENTING THE FUNCTION. Suppose that we have given two lines and we wish to find the co-ordinates of their point of intersection. For example: $f(x)=2x/3+5$ and $g(x)=4x-1$. We here have two functions of x and we show that they are different functions of x by using a different first letter in the function symbolism. We represent one by $f(x)$ and the other by $g(x)$. $f(6)$, for example, is found by substituting 6 for x in the first expression. This gives $f(6)=(2/3)6+5=9$. We find $g(6)$ by substituting 6 for x in the expression $g(x)=4x-1$. This gives $g(6)=4(6)-1=23$.

THE GRAPH OF A SECOND DEGREE FUNCTION. (See

topic, How to introduce a simple rule of differentiation as an aid in curve plotting, at the end of this article.)

AN ILLUSTRATION OF THE DERIVATIVE. Given: $y=x^2-4x+5$ and a tangent to the curve at the point (2.5, 1.25). See figure.



We wish to find the slope of the tangent line. To do this draw a horizontal line through the point of tangency. Then from any point in the tangent line drop a perpendicular to the horizontal line. The ratio of the perpendicular to the segment cut off is the slope of the tangent line. This perpendicular represents geometrically the differential of the dependent variable and the segment cut off represents geometrically the differential of the independent variable. The former we represent by dy and the latter by dx The ratio of these two differentials; dy/dx, is the derivative of the function with respect to the independent variable x. Our illustration also shows that the derivative is a general form for the slope of a line to a curve. The derivative of x^2-4x+5 is $2x-4$. (The rules for finding the derivative will be given in the discussion that follows.) Using our symbol for the derivative, we have $dy/dx=2x-4$. Now let us substitute in this general form the co-ordinates of the point of contact. Since the y-co-ordinate does not appear in the derivative, we need use only the value $x=2.5$. The symbolism for evaluation is as follows: $\left.\frac{dy}{dx}\right]_{x=2.5} = 2(2.5)-4=1$. Therefore the slope of the tangent line is 1.

RULES OF DIFFERENTIATION.

MINIMA AND MAXIMA VALUES OF PARABOLAS. (See illustrations in topic at the end of this article.)

APPLICATIONS OF MINIMA AND MAXIMA.

THE GRAPHS OF FUNCTIONS OF HIGHER DEGREE THAN THE SECOND. (See illustration in topic at the end of this article.)

PART II

As may be surmised from the Preface, the order of topics up to minima and maxima is in general the same as that in Part I.

Then:

The Differential.

A Reason for Studying Integration. One of the reasons for studying integration is that it enables one to find the areas and volumes of figures which cannot be found by the ordinary geometric methods. Integration the Reverse of Differentiation. A First Attempt at a Table of Integrals. The Definite Integral. The Length of Arc. The Volumes of Certain Solids. Formulas and Applications involving Logarithms. Formulas and Applications involving Trigonometry.

Objective Practice Exercises in Differentiation and Integration. (A first draft of these tests was written up by Miss Couillard. This article appeared in SCHOOL SCIENCE AND MATHEMATICS, December, 1926.)

I shall here briefly try to indicate the nature of the chapter on trigonometry for those pupils who have not yet had this subject. The fairly original treatment of this beginning trigonometry, I believe to be a big improvement over the traditional methods. The method has its roots in the way the definition of a trigonometric function is stated. Let us first consider the tangent function. We may define the tangent of an acute angle as the ratio of two lines obtained in the following manner: *From any point in one side of the angle draw a line perpendicular to the other side. The ratio of the perpendicular to the segment cut off is the tangent of the angle.* This definition may seem little different from the traditional ones, but its form insisted upon and extended avoids the necessity of the straight-jackets of the quadrant system and the right/triangle chapter. It will make easy the transition from acute angles to obtuse angles and an understanding of a *single simple rule* whereby the learner can find, so far as the use of the tables is concerned, the functions of any angle greater than 90° in terms of the same function of the corresponding acute angle.

Before extending the definitions of the trigonometric functions to include obtuse angles, we must first make an *agreement* with respect to *direction* in reference to the sides of an angle. We agree that beginning at the vertex direction is *positive* along either side of the angle. Then, if we produce the sides through the vertex in the opposite direction, it follows that beginning at the vertex the direction is negative along the sides of the angles produced in this way. We now see how easy it is to extend our definition of the tangent of an acute angle. *From any point in one side of the*

angle draw a line perpendicular to the other side or the other side produced. The ratio of the perpendicular to the segment cut off is the tangent of the angle. If the segment is negative, the ratio is negative. Hence, the tangent of an obtuse angle is a negative number. Since the solutions of oblique or general triangles do not involve angles greater than 180° the discussion of the functions of such angles is postponed until later. The benefits of the scheme here indicated are more apparent as the method is extended to cover angles of any degree.

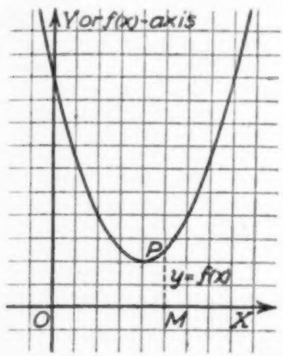
To find the value of the function of an angle greater than 90° from the tables, it is only necessary to notice its algebraic sign and its corresponding acute angle. It is seen that the corresponding acute angle of a given angle greater than 90° is that other angle which lies between the terminal side and the initial side or the initial side produced. We may now say that *the positive function of an angle greater than 90° equals the same function of its corresponding acute angle, and the negative function of an angle greater than 90° equals "minus" the same function of its corresponding acute angle.* Thus, $\cos 217° = -\cos 37°$.

For a class in applied trigonometry, this simple rule then makes unnecessary the chapter on the thirty to forty reduction formulas, a chapter that in its later use usually causes more confusion than helpfulness.

How to introduce a simple rule of differentiation as an aid in curve plotting.

The class is supposed to have had training in the plotting of straight lines.

Let us plot the curve x^2-4x+5; that is, for each value assigned to x represent the corresponding value of the expression by means of a graph. It is as follows:



Scale: 1 unit = 2 spaces

We see that as x is given values in the neighborhood $x=2$ the curve has a turning point. This means that when $x=2$ the value of the expression is less than for any other value of x. We say that the expression has a minimum value when $x=2$.

We found by trial the value of x which would make the expression a minimum. Is there an exact method of finding that value of the independent variable which will make the expression a maximum or minimum?

Yes, by means of another one of the fundamental operations called differentiation. This is the process of finding the derivative of an expression; that is, a certain type of derived expression. Let us first state the simple rule that we use in this type of graph work, use it a little to get somewhat familiar with it, and then give some explanation of how we get the rule.

First. Consider a term of the expression which consists of the independent variable with an exponent. (Its coefficient is unity in this case.) The derivative of this term is the product of the exponent times the variable with its exponent diminished by unity. Thus, the derivative of x^2 is $2x$ and of x^7 is $7x^6$. Since the coefficient of a term merely indicates the number of times the term occurs in the expression, the derivative of a term with a coefficient other than unity is the coefficient times the derivative of the variable with the exponent. Thus, the derivative of $4x^3$ is $12x^2$. The algebraic sign of the derivative is the same as that of the term of which it is the derivative, and the derivative of the entire polynomial is the algebraic sum of the derivatives. A constant term may be written $7x^0$. Its derivative is 0.

Second. The value of the variable that will make the derivative zero will make the expression a maximum or minimum or neither. In graph work it can easily be seen which of these conditions is the true one.

Illustration. Our expression is x^2-4x+5. Its derivative is $2x-4$. Now the value of x that will make this equal zero is the value of x that will make the expression x^2-4x+5 a minimum. To find this value of x we set $2x-4=0$ and solve for x. Hence, $x=2$ when substituted in the expression x^2-4x+5 will make this expression have a minimum value. Its minimum value is 1. Therefore, the point (2, 1) is a turning point of the curve.

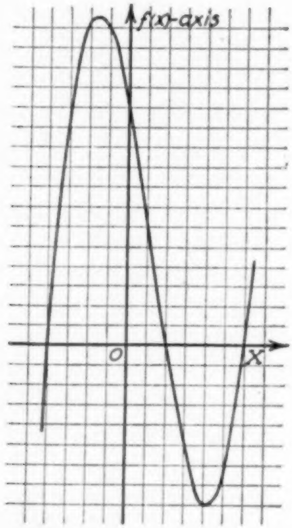
Example. Plot x^3-2x^2-5x+6. Where it crosses the two axes is easily found. The turning points may be found as follows: the derivative is $3x^2-4x-5$. Set this equal to zero. We find that $x=2.12, -.79$. The former gives the minimum value -4, the latter the maximum value 8.2. Hence, the turning points are $(2.1, -4)$, $(-.79, 8.2)$. The figure is shown on the following page.

Results of Questionnaire

Results of a questionnaire on the desirability of offering a summer session course in simple calculus. Data gathered Spring, 1928.

The questionnaire was sent to 76 summer sessions of whom 49 replied. It contained a description of the type of course and two questions, as follows:

"A simple course in the calculus of algebraic polynomials to give some



Scale: 1 unit = 2 spaces

understanding of derivatives, differentials, and integrals. Prerequisite: only high-school mathematics.

1. Is a summer session course in simple calculus based on only high-school mathematics or equivalents offered in your Summer Session?

2. If not, do you think that some time in the future it may be desirable to offer such a course?"

The replies could be fairly well grouped as follows:

Number	*Group*	*Description of Group*
6	A	Yes, as answer to question 1
20	B	No for 1. For 2, Yes, Probably, or Endorse such a course
11	C	No for 1. For 2, No with remarks—usually, not the type of institution where such a course would fit or ideas given in another course
5	D	No for 1. For 2, No, without remarks
7	E	No for 1. For 2, No, with remarks usually showing disapproval of such a course

There are many peculiarly valuable comments in the replies. The serious and sympathetic consideration given the questionnaire is very gratifying.

Apparently, from the foregoing tabulation of results and more especially from the tenor of the remarks in the replies, the consensus of opinion is in favor of offering some such course in simple calculus as described in the questionnaire.

SPOTS ON SUN NOW ON DECLINE.

Spots on the sun are now declining in number, and the minimum of the present cycle will probably occur in 1934, it is indicated by records gathered by *Science Service.* From November, 1929, to January, 1930, was a time of considerable activity, but from March to June there was a considerable decline. In July, however, the numbers increased somewhat, but this is believed to be just one of the "ups and downs" over short periods that occur inside the eleven year cycle.—*Science Service.*

ANIMAL COLLECTIONS AS AN AID IN THE TEACHING OF BIOLOGY.

BY FRED R. CLARK,
Southeastern Teachers College, Durant, Okla.

For the past year at Southeastern Teachers College we have been using animal collections as a vital part of the regular work in freshman Zoology. Our period of time for the course in Biology Two (Zoology) is very limited as compared to most schools, being of but nine weeks duration, and one week of this is also practically a loss due to registration and enrollments and examinations. So with the very limited time at our disposal we are forced to acquaint the student with as many of the facts in Zoology as possible. Our students will become teachers in the grade schools and high schools of the State—very few will go into college teaching as a profession and few will become professional Zoologists. Our problem then is directed to the end of turning out good public school teachers. Of necessity the course should prepare them in the basic things of Zoology, in its theories, its facts, its literature, its methods and problems. It should help the student to prepare for his work as a teacher, let us say, of Physiology, Nature study, Biology, Zoology or General Science. It should make him able to use his knowledge for the general benefit of the community to which he will belong as a teacher and a leader.

The basic things in Zoology can be taken care of by the usual methods of giving lectures and talks, by using lantern slides, by giving quizzes and examinations and requiring reports and themes to be presented. The use of a text book is also a great help and in the laboratory the customary drawings, dissections and studies can be made.

However, we are coming to note that this is a practical age. We believe in studying the things about us that we will be more directly concerned with and we believe that we learn by doing and by participating. Agassiz has said, "Study nature not books".

The animal collection fulfills this particular requirement and relieves the Zoologist of the constant accusa-

tion that his work is but theoretical and academic and not practically associated with the animals with which he deals.

Our experiences with this additional aid to teaching have already shown that it makes a fuller, more well rounded course than without it.

We have tried several types of collections. Sometimes we have the student collect specimens of animals to represent the various phyla of the Animal Kingdom. We have set a requirement of twenty-five to fifty animals to be brought in, properly classified and labeled. In an elementary course such as this we do not expect too great exactitude nor as good results as from advanced students. However, the student should know at least the phylum to which each of his specimens belong, and as much more of its classification as he can find out. He should tell where he found his specimen, the date, the habitat and so forth.

We have also varied this procedure by assigning so many points to each phylum or subdivision of the Animal Kingdom and requiring the student to make, say one hundred points from these groups.

The following outline gives an idea of this method:

Collections Representing the Principal Phyla of the Animal Kingdom

Points	Limit	Phyla
5	1	Protozoa
10	2	Porifera
10	1	Coelenterata
10	1	Ctenophora
10	2	Platyhelminthes
10	2	Nemathelminthes
10	2	Echinodermata
5	2	Annelida
5	4	Mollusca
5	15	Arthropoda
5	15	Chordata

Specifications for Collections

1. One hundred points required.
2. Five phyla must be represented of the eleven.
3. All specimens must be properly classified and labeled.
4. No more than the limit may be taken for any given phylum.
5. Animals protected by law are not acceptable.

It is also feasible to use collections to illustrate certain types of animals, certain habitats or associations of animals, food habits and so forth.

Teachers who do not care to have actual collections made can devise a simple form card for making field notes on specimens and can secure much the same benefits of classification, observation and practical knowledge as the other method.

Our collections here have gone through several stages of development. At present we furnish the students with the killing and preserving agent—formaldehyde—and expect them to furnish the bottles, vials and jars to contain the animals.* We give them general collecting directions at the beginning and needful precautions about the dangerous species. We also help them take care of larger animals in the regulation manner and store these for them at the laboratory in jars or containers. We do not encourage cruelty to animals and we do everything on a strictly ethical plane and as scientifically as possible. Students are not required to collect any particular species or genus of animals and are given as much latitude as possible. We try to encourage the student to have a scientific attitude of mind toward the collection and discourage sentimentality and sensationalism.

Students are led rather than forced in collecting and encouraged rather than driven. For example we know that most people dislike snakes so we do not force them to collect snakes. Instead they may bring lizards, turtles, alligators, and what not! Many will after a time loose their first fear and add such to their collection.

One point in favor of the collection is that it makes a great appeal to the collecting instinct which most Americans seem to have. Who has not collected stamps, marbles or butterflies at some time or other? Many students tell us that the collection has been the means of interesting them in Zoology and practically all think it makes the subject more practical and out of the realm of the academic and pedantic.

---

*Further details of the methods of collecting will be found in an article soon to be published by the writer in the Oklahoma Teacher Magazine.

PROBLEM DEPARTMENT.

CONDUCTED BY C. N. MILLS,
Illinois State Normal University.

This department aims to provide problems of varying degrees of difficulty which will interest anyone engaged in the study of mathematics.

All readers are invited to propose problems and to solve problems here proposed. Drawings to illustrate the problems should be well done in India ink. Problems and solutions will be credited to their authors. Each solution, or proposed problem, sent to the Editor should have the author's name introducing the problem or solution *as on the following pages.*

The Editor of the department desires to serve its readers by making it interesting and helpful to them. Address suggestions and problems to C. N. Mills, Illinois State Normal University, Normal, Ill.

SOLUTIONS OF PROBLEMS.

1099. *Proposed by George Sergent, Tampico, Mexico.*

Given a triangle ABC, to place between AB and AC a line XY of given length, so that BX = AY.

Solution by Arthur Haas, New York City.

Let ABC be the triangle; L, the length of the given line. Required to find two points, X and Y, whose distance from each other shall be equal to the length L, and whose distances from A, measured on AB, and from B, measured on BC, shall be equal.

1. Bisect the angle B.
2. With A as a center and radius L, draw arc cutting this bisector at D and D_1.
3. From D, draw DY parallel to AB; from Y draw YX parallel to AD. XY will be the required line. (Two solutions.)

Proof. AXYD is a parallelogram, and BYD is an isosceles triangle. Therefore, AX and BY are each equal to DY; Also AX = BY, and XY = AD, which was constructed equal to L.

1121. *Proposed by W. E. Buker, Leetsdale, Pa.*

Find a positive root of
$X+X^{\frac{1}{2}}+X^{\frac{1}{3}}+X^{\frac{1}{4}}=5.$

Solved by Norman Anning, Ann Arbor, Mich.

By inspection, X is between 1 and 2. Put $X=Y^{12}$. Then Y must be very slightly greater than 1. Into the equation

$$Y^{12}+Y^6+Y^4+Y^3=5,$$

put $Y=1+h$ and neglect all powers of h above the first.

$$1+12h+1+6h+1+4h+1+3h=5.$$

This yields for h the approximate value 0.04. By using a set of computing tables, we find that when $Y=1.035$, $Y^{12}+Y^6+Y^4+Y^3$ equals

$$1.5111+1.2293+1.1475+1.1087=4.9966=5-0.0034.$$

In order to get a better approximation than 1.5111, let us put $Y_1=1.035+k$ and carry through the process again. As a result, $X=1.51272$.

Also solved by *Louis R. Chase, Newport, R. I.;* and by *George T. Johnson, Brainerd, Minn.*

1122. *Proposed by Louis R. Chase, Newport, R. I.*

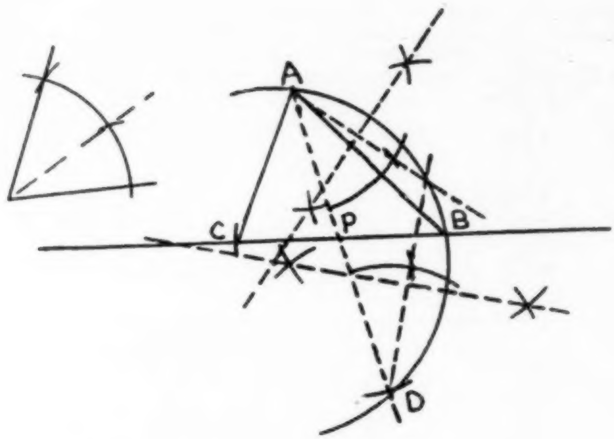
Given the line of base, mid-point of base, vertex, and vertex angle, to construct the triangle. A geometrical solution is desired.

Solved by George Aabel, Redwood City, Calif.

Draw AP and continue its own length to D. Then by using AD as a chord, construct a segment of a circle which will contain the supplement of the vertex angle, the arc cutting the line of the base at B. Mark off PC = PB; and draw AC and AB. ABC is the required triangle.

By drawing BD and CD, a parallelogram is formed, since the diagonals BC and AD bisect each other. Therefore, $\angle$A equals the given angle since $\angle$B is the supplement of the vertex angle by construction.

Also solved by *Ruby Van Sant, Oklahoma City, Okla.; F. A. Cadwell, St. Paul, Minn.; Marguerite Chamless, Norman, Okla.; C. H. Sisam, Colorado Springs, Col.;* and the *Proposer.*



1123. *Proposed by J. K. Thornton, Fillmore, Calif.*

How many acres in a square field that takes as many board feet of fence 4 feet high, as the field has area in square feet?

Solved by George T. Johnson, Brainerd, Minn.

Let X = No. of ft. in the length of one side.

Then the area of the square field is X^2 sq. ft.

The perimeter is $4X$ ft. Hence $X^2=16X$, and $X=16$ ft. The area of the field is 256 sq. ft., or .0058 A.

Also solved by Sudler Bamberger, Harrisburg, Pa.

1124. *Proposed by H. D. Grossman, Brooklyn, N. Y.*

Consider two congruent triangles that can be brought into coincidence only by a rotation of one of them through a third dimension. How, by cutting the triangles, could we effect this coincidence by motion in a plane only?

Solved by Louis R. Chase, Newport, R. I.

Since the two aspects, front and rear, of an isosceles triangle are congruent, the problem will be solved if the triangles can be divided similarly into isosceles triangles.

A right triangle will be so divided by the median upon the hypotenuse.

A scalene triangle can first be divided into right triangles by the altitude upon the longest side.

An acute triangle will be divided into isosceles triangles by lines from the circum-center, which lies within the triangle, to the three vertices.

Construction without proof.

Letter the vertices of one of the given triangles A, B, C, in such a way that the triangle has no angle greater than the angle at A. In BC construct the point D such that $AD \perp BC$. D will fall between B and C. Bisect AB at L. Bisect AC at M. Cut the triangle along the lines DL, DM. In the plane turn the $\triangle LBD$ about L into the position LAD_1 where B coincides with A and where D and D_1 are on opposite sides of AL. Similarly turn $\triangle MCD$ into position MAD_2. The resulting $\triangle DD_1D_2$ can, by rotation and translation in the plane, be brought into coincidence with the second of the given triangles.

1125. *Proposed by F. P. Hennessey, Astoria, L. I., N. Y.*

(*Taken from a recent examination.*) There are three numbers such that (1) the sum of the squares of the first and second, added to the first and second equals 32; (2) the sum of the squares of the first and third equals 42; (3) the sum of the squares of the second and third, added to the second and third equals 50. Find the numbers.

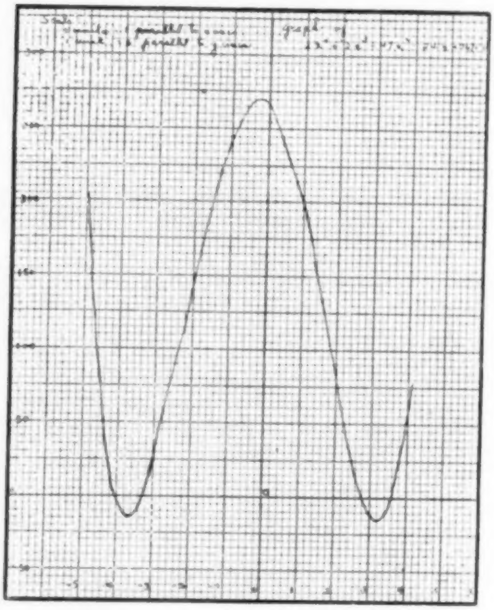
Solved by Tillie Dantowitz, Philadelphia, Pa.

Eliminating y and z from these equations, the resulting equation in x is

$$2x^4+2x^3-47x^2-24x+267=0$$

Using Horner's method, the values of x are 3.592, 2.772, -3.295, and -4.069. The values of x, y, and z are given in this table.

x	y	z
3.592	3.47	5.34
3.592	−4.47	5.34
2.772	4.17	−5.86
2.772	−5.17	−5.86
−3.295	4.47	−5.58
−3.295	−5.47	−5.58
−4.069	3.95	5.04
−4.069	−4.95	5.04



1126. *Proposed by I. N. Warner, Platteville, Wis.*

A railway embankment across a valley has the following dimensions: width on top, 20 ft.; width on base, 45 ft.; height, 11 ft.; length of top, 1020 yd.; length at base, 960 yd. Find the volume in cubic yards. Solve by prismatoid formula and check by cutting into other known solids.

Solved by Sudler Bamberger, Harrisburg, Pa.

The figure is a top view of the embankment.

The area of the upper base, B_1, is 61,200 sq. ft.

The area of the lower base, B, is 129,600 sq. ft.

The area of the mid-section, M, is 96,525 sq. ft.

The altitude of the solid is 11 ft. Hence the volume of the solid is $h(B_1+B+4M)/6=1{,}057{,}650$ cu. ft.

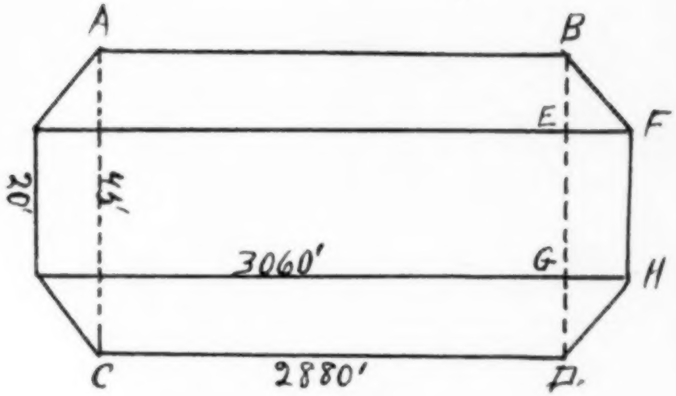
We may pass planes through the embankment having the projections AC and BD. The volume of the central prism thus formed is 1,029,600 cu. ft.

$2\times$vol. prism EFGH $=19{,}800$ cu. ft.

$4\times$vol. pyramid DGH $=8{,}250$ cu. ft.

The sum of these three volumes is 1,057,650 cu. ft.

Also solved by *George T. Johnson, Brainerd, Minn.*



PROBLEMS FOR SOLUTION

1139. *Proposed by Norman Anning, University of Michigan.*

Discuss the function

$$\frac{\cos X - \cos 3X}{\cos X - \cos^3 X}$$

as X (in radians) takes all values from 1 to 10.

1140. *Proposed by H. W. Georges, Medicine Hat, Alberta.*

A grocer has a platform balance, the ratio of whose arms is 9 to 10. If he sells 20 lb. of merchandise to one man, weighing it in the right-hand pan, and 20 lb. to another man, weighing it on the left-hand pan, what per cent does he gain or lose by the two transactions?

1141. *Proposed by Arthur Haas, New York City, N. Y.*

Given an angle and two points outside the angle. Required a point, X, in one side such that if connected with the two given points, the intercepts within the angle shall have a given ratio.

1142. *Proposed by E. C. Kennedy, El Paso, Texas.*

If A, B, and C are angles of a plane triangle, prove that

$$\cos A \cos B \cos C \leq 1/8.$$

1143. *Proposed by the Editor.*

Taken from an article in August-September, American Mathematical Monthly, written by Gladys Gibbens, University of Minnesota. In this article is an analytical proof of the following construction of a regular pentagon.

Draw a circle with OA_3 as radius, and a concentric circle whose radius is twice as large. Draw the horizontal and vertical diameters as indicated. See figure on the following page.

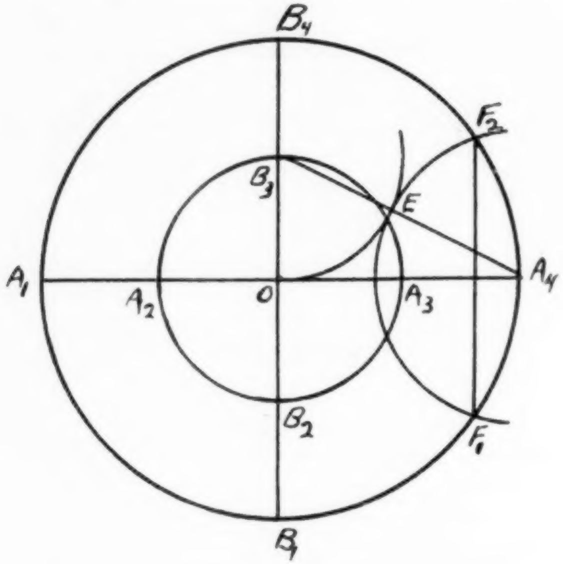
Draw B_3A_4, meeting a circle with B_3 as center and radius equal to OB_3 at E. Draw a circle with A_4 as center and radius A_4E, meeting the large circle at F_1 and F_2. Then F_1F_2 is a side of a regular pentagon inscribed in the circle $A_1B_4A_4B_1$.

Required (a) a proof suitable for High School pupils (b) a synthetic proof.

1144. *Proposed by the Editor.*

Taken from a recent College Entrance Examination.

The radius of an iron sphere is 8 in. It is to be covered with lead. How thick must the lead be that the surface of the lead may be three times that of the iron?



MEMOIRS OF AN AQUARIUM.*

BY MARJORIE L. BETTYS.

Chapter I.

The little aquarium with the green trimmings had been waiting patiently at the pet shop, and now it came. It was artistically planted and arranged, and showed to advantage the brilliant colors of the little fish.

With this aquarium came ten wee tropicals. A male and female Guppy, a male and female Zebra fish, a male and female Plati, and four month-old Guppies. The Guppies are live bearers, and it so happened that little Lady Guppy was about to perform this marvelous feat uncommon to most species of fish. When we children were not watching the aquarium, then Mother, Aunty, or Vanny would watch with vigilance. I felt anxious lest something should happen. After a few days, however, Mother consented to letting us buy another aquarium planted thickly with hiding plants for the babies. For when the little ones are very little, there are hungry mothers and fathers that would like nothing better than to gobble them up.

Chapter II.

Lady Guppy, so named, suddenly found herself lifted into the air and dumped somewhere. When she came to her senses, she found herself in an entirely different world, which didn't appeal to her. One reason was that she simply didn't like the plan of things, another was that she didn't know what was going to happen.

So a few days of misery passed and then, one night I came from school and looked carefully at the aquarium (and Lady Guppy). What I found in there were eleven little such-and-suches swimming around like any big, beautiful Lady Guppy. So the miserable Lady

*This article consists of the first three chapters of a "book" written by a seventh grade student. It suggests a project correlating English and science.

was lifted up in the net and put back in her heaven, and the Eleven Snookums started to breast the current.

The zebra fish were very much beloved by us. They were so flashy and graceful and when the food came dribbling down, they just gracefully swam through and took a piece with them.

But later we noticed that something decidedly wrong was happening to one of them. His tail seemed to droop and he went around in a crazy manner. I don't know whether it was a disease or just a sign of old age, but I do know that he wasn't acting in a healthy way. Then one day it happened, and we lost one of our beautiful zebra fish.

So ever since, the other one has gone around in a distracted manner, not caring for a single thing in the world but food. I think, though, that some day soon he will have another interest in life.

The platys are quiet and peaceful. They take a stroke, then stop, and sometimes stay still for a whole minute waving their fins. They can swim pretty fast, though, when they wish to. The male makes a very pretty picture with his bright orange and his black spots. We named our male "Jaguar" or "Leopard" or something like that. The only trouble is that we haven't found yet how to breed these two fish.

Chapter III.

One day I was watching the aquarium very closely. I saw Little Rainbow, the male Guppy, twisting himself all out of shape and holding himself that way, and at the same time turning around in front of Lady Guppy. For a while I couldn't imagine what he was trying to do, then I solved it. He was showing off his colors to Lady Guppy, but the haughty lady would pay no attention. She just went on picking at leaves and sand.

Little Rainbow is the most beautiful male Guppy I have ever seen. He has many brilliant colors that blend beautifully and flash in the sunlight. Sometimes the black spot on his ribs is small and round. At other times it blurs all over like an ink spot.

Lady Guppy is a wonderful specimen of femininity. Some people show us what they call a very "large female" and we compare it with our wondrous lady. Then this very large female turns into a very small one.

The fish seem to enjoy swimming in and out the plants. Lady Guppy is clumsy about it, though, when she is hotly pursued by proud males. I believe that an aquarium without plants is like a man without a nose. The fish would have a hard time breathing, because they give off oxygen, and they certainly add color to it.

A SCIENTIFIC BASIS FOR HEALTH INSTRUCTION IN PUBLIC SCHOOLS.

A study recently issued by the University of California Press, entitled "A Scientific Basis for Health Instruction in Public Schools," by Dr. Laura Cairns, considers first, the scientific determination of the proper content for health instruction in schools and, secondly, an examination in the light of the facts thus established of the health instruction give in public schools at the present time.

The material which should be included in health instruction has been determined by the author from analysis of the leading causes of mortality and morbidity, and of the incidence of minor ailments and physical defects, and from a study of the factors which authorities recognize as influencing these departures from the normal.

The first four chapters of this study state the chief causes of death and of sickness and disabilities and following these statements in each case are listed the items of health instruction, a knowledge of which is necessary to prevent or reduce these conditions. These items are chosen according to authorities referred to in specific or general references. These facts which should be taught have been listed and curriculum makers in the sciences, social sciences, physical education, and health education may have from this study specific information to guide them in their further work. Data were gathered from elementary, junior, and senior high schools. The information gathered and tabulated has been used as a basis for comparing the health instruction given in the various schools, and for determining to what extent this instruction covers the essential items.

The following are some of the conditions found to exist in the schools visited:

There is need for a better selection and a better organization of instructional content. Time which could be used to advantage in teaching essentials is too often wasted on the teaching of non-essentials.

Health instruction which fails to teach the fundamental fails to function in health promotion. This failure is largely due to the fact that teacher-prejudices rather than scientific information determine health instruction.

The responsibility for health instruction is not always carried by those who should assume the major portion; that is, by the teachers of the fundamental sciences, who have the necessary foundation and facilities.

The chief responsibility for health instruction should not be placed on the physical education departments. They have other objectives than health education and cannot take the time from their activity programs to give pupils the scientific background necessary for intelligent health practices. Any attempt to assume this responsibility by groups other than those prepared to teach the underlying principles and having laboratories where the students may have first hand experiences, results in dogmatic instruction.

In courses where laboratories are provided, there is a wide variation in the amount of time devoted to laboratory work. The instruction varies greatly and evidences a lack of effective standards.

In the elementary grades one of the main weaknesses is that too much time is spent on the teaching of non-essentials and many of the essentials are omitted.

In the junior high schols biology and general science, in the senior high schools physiology, biology, and general science include the greatest number of the essentials of health instruction.

The present survey shows, then, that except for physiology, biology and general science include more of the essentials of health instruction than any other subject. This would seem to indicate that biology and general science, since they are more widely offered than physiology, are best able to carry the major responsibility for health instruction. There is need, however, to put more emphasis on human biology and physiology.

Physical education, household science, physics, and chemistry, as well as other groups, have definite contributions to make to the health program. Each of these groups could make further contributions if the giving of health instruction were worked out according

to a generally accepted plan. Because so many different subjects offer opportunities to work out a carefully organized sequence of subject matter for all, and at the same time, of course, to coordinate the efforts of the various groups in order that each may have a better understanding of the relation of his particular contribution to the whole. At present, however, in the survey made by the author, no sound general program was found.

There is a wide variation in the percentage of time given to health instruction in these contributary subjects.

The present scheme permits a student to go through the public schools without any health instruction or with but a limited amount.

High schools, especially, lack a definite plan for health instruction. Comparison of the total number of students enrolled in classes offering health instruction with the total school enrollment shows that only a small percentage are receiving health instruction at any one time.

BIOLOGY PROJECTS.

By Myrtle Creaser, *Kenosha, Wis.*

What can be done in the way of extra projects in Biology?

The projects which have been a decided success during the time I have taught Biology are as follows:

I. Organized Audubon Clubs which have a
   1. Meeting for bird study every month.
   2. Bird feeding stations placed in the woods.
   3. Bird house exhibits.
   4. Keeping of bird calendars.
   5. Public programs.
   6. Lantern slides procured and shown to the public.
   7. Parties.

II. Making material needed for regular work such as
   1. Germinating boxes.
   2. Window boxes.
   3. Apparatus to show ability of various soils to retain moisture.
   4. Simple breeding cages.
   5. Animal cages.
   6. Collection of insects.
   7. Preparing bird skins.
   8. Material to show correct method of ventilation.
   9. Material to show mechanics of breathing.
   10. Collection of animals in museum jars.
   11. Aquarium cases mended or made.

III. Celebration of various days such as
   1. Arbor Day (planting of trees and shrubs—program).
   2. Apple Day (posters and program).
   3. Child Health Day (program, posters, weighing young people).

IV. Class Project—The making of a book for the library, "Lives of the Great Scientists."

(This year the project which my class was most interested in was the making of a book for the library on the "Lives of the Great Scientists." This was conducted as follows: Each one in the class was assigned a scientist (Moon's Biology was used as a basis). A report was given in class, then each one wrote this report in first class shape, handed it to one of the classmates who took charge of making

these reports into a book. An index page and an attractive cover was made. Several of the members in order to complete the book reported on several scientists. The book was then presented to the library for use in successive classes.)

V. Making of booklets on
  1. Birds.
  2. Mammals.
  3. Health.

VI. Class Project—The construction of a game entitled "Great Scientists."

(Each child was at first assigned a scientist—as the report was given in class, the class decided what events should be placed on a small card. A picture of the scientist was procured and pasted on the top of the card. The game was played in this manner. First an umpire was appointed. Someone read the information from the cards. Those listening raised their hands when they knew the scientist's name. The umpire decided who was first. The card was given to the first one knowing the name.)

VII. Making of charts.

1. Fruit chart (Botanical fruits on a large cardboard labeled as to capsule, legume, pod, etc.).

2. Medicinal plants (Supplied to one of the boys who worked in a drug store. These plants were pasted on cardboard and labeled).

VIII. Solution or attempted solutions of problems which at the basis are biological problems such as—
  1. How to reduce the drinking of alcohol.
  2. How to reduce the destruction of our forests.
  3. Eugenics—How to improve the Human Race.
     A. By improving the future inheritance.
     B. By improving the environment.

(These general problems are presented to the class with the following conditions: List of books, charts, diagrams, etc., which contained material were presented to the group. Each one was invited to review the literature, confer with each other, consult their parents and other older people as to the best methods of solving the problem. After a week or more of time each one wrote his solution.)

POTASSIUM FOUND TO GIVE OFF RAYS LIKE X-RAYS.

The common chemical element potassium gives off gamma rays similar to X-rays or the gamma rays of radium. At the State Radiological Institute here Dr. F. Behounek has confirmed the researches of Dr. W. Kohlhörster which gave evidence of these rays from potassium about two years ago.

Dr. Behounek finds that potassium chloride really emits gamma rays, the intensity of the rays being proportional to the amount of potassium. He also finds that there are two groups of gamma rays, one about as penetrating as the similar rays from radium, the other about twice as penetrating. However, their intensity is very low, so that very delicate apparatus is needed to detect them. It has been supposed the potassium resembles radium in that it is constantly decaying, with the liberation of gamma and other rays, and that in 1,000,000,000,000 years half of a given amount of potassium would have disappeared into radiation. Radium will lose about half of its original mass in 1750 years. But Dr. Behounek finds that the intensity of the gamma rays from potassium is much less than would correspond to the generally accepted period of decay.—
—*Science Service.*

THE CENTRAL ASSOCIATION OF SCIENCE AND MATHEMATICS TEACHERS (INCORPORATED) THIRTIETH MEETING.

The annual meeting of the Central Association will be held at Lincoln High School, Milwaukee, November 28 and 29.

This is the first time the Association has gone to Milwaukee for a meeting. Milwaukee has provided a new high school in which to hold the meeting and loyal support from the teachers of Milwaukee and the whole state has been promised.

Milwaukee is easily reached from all directions. The North Shore Electric operates hourly trains from Chicago. Fare-and-a-half for the round trip on the certificate plan has been granted on condition three hundred certificates are secured. These rates are good over the North Shore Electric.

The General Program provides instructive and inspiring lectures that should interest and benefit all:—Director Edward A. Fath of the Goodsell Observatory on "This Expanding Universe" will bring your information down to date on the marvelous advances in Modern Astronomy made by our large observatories.

Professor Clarence Comstock, Past President of the Association and Mathematician will present a philosophical discussion of the thinking processes involved in Mathematics and in other activities.

Professor Louis Kahlenberg of the Chemistry Department, University of Wisconsin will relate Chemistry and Biology to every day life under the caption "Some New Things about Meats."

Professor H. C. Morrison, School of Education, University of Chicago will speak on "The Teaching Unit." This subject also will be one of the items considered in the Section Meetings.

The annual dinner will be served by the Lincoln High School Cafeteria at one dollar. The program following this will be interesting, instructive and popular in character.

The Section Programs, Friday afternoon will be especially good. William Gould Vinal, Professor of Nature Education, Western Reserve University will address the Biology Section on "Humanizing the Teaching of Biology."

The Chemistry Section will be addressed by Mr. Ira Davis of the High School of University of Wisconsin, Mr. Fred G. Anibal of the High School of the University of Chicago and Professor J. O. Frank of the Oshkosh Teachers College. Saturday afternoon this section will conduct a tour through the Lakeside Power Plant.

The General Science Section is offering Mr. G. A. Bowden of the High School of Cincinnati University, Mr. Paul G. Edwards, Supervisor of Science of the Chicago Public Schools, Mr. Dennis C. Haley of Teachers College of the City of Boston, Mr. W. L. Beauchamp of the University of Chicago and Mr. H. A. Webb of the George Peabody College.

The program of the Geography Section gives every assurance of being one of the most unique and profitable programs of the entire session. Special announcement is given below.

In Mathematics, the Section Program consists of Mr. Allison B. McCain of the Washington High School, Milwaukee, Dr. John P. Everett, Western State Teachers College, Kalamazoo, Dr. E. R. Breslich of the University of Chicago and Mr. Charles A. Stone of the High School of the University of Chicago.

The Physics Section Program presents a variety of problems and demonstrations in the teaching of Physics. Eleven short snappy numbers will be given by teachers from Chicago, Milwaukee, Madison, St. Louis, and other places.

It is evident that much profit should be gained from any of these programs.

Many of the most progressive publishers and supply houses will exhibit Science and Mathematics materials at the meeting. No better opportunity is afforded for the teacher to study the latest developments in materials for his subject. These exhibits will be free and accessable at all times.

The social phase of this meeting should not be neglected. The meeting is attended by many of the most alert and progressive teachers of the central states. Invaluable friendships and acquaintances may be formed by regular attendance. Men and women sufficiently devoted to their

profession to give up their holiday to its advantage are an inspiring group with whom to be allied.

SCHOOL SCIENCE AND MATHEMATICS is the official organ of the Association, and is owned and controlled by the Association. Membership in the Association includes a subscription to the magazine and costs two dollars and fifty cents per year. Get in touch with the treasurer, Mr. Ersie Martin, 134 North Drexel Avenue, Indianapolis, Indiana, and take steps to become a member of this Association.

ATTENTION GEOGRAPHERS! A FIELD TRIP!

The geography section of the Central Association of Science and Mathematics Teachers will hold its annual sectional meeting at 1:00 p. m. Friday, Nov. 28th, at Lincoln High School, Milwaukee.

Miss Alice Hahn of Proviso Township High School, Maywood, Ill., will speak on "Methods of Vitalizing Commercial Geography." Miss Hahn has orginated some very successful methods of presenting geography and will distribute mimeographed copies of some of them at the meeting.

Dr. Loyal Durand, Associate Professor of Geography, University of Wisconsin will conduct a field trip on the subject "Urban Geography—taking Milwaukee as a Unit." We are fortunate in having Dr. Durand for our leader as he is not only a specialist in urban geography but also knows Milwaukee well, having lived there for many years.

Members of the section (and others who are interested) will charter a bus and travel about the city on a geographic sight-seeing trip, Dr. Durand lecturing enroute. Park plans, boulevards, lake shore development, in short, the city plan will be explained to us. Harbor problems, transportation facilities, leading factories, power plants, sewage disposal, water supply, adjustment to economic and political changes, volume of trade, etc., will be among the topics discussed and observed.

Since this trip will be of unusual value to all of us and since only a limited number can be accommodated on a bus it is suggested that you make a reservation for a seat at the earliest moment. Write to Miss Katherine Ulrich, Oak Park High School, Oak Park, Illinois. Our policy will be "First Come, First Served."

MALE TOADS CHANGED TO FEMALES BECOME MOTHERS OF MALES.

Toads have won the distinction of being the first males to give birth to an offspring. Several male toads were changed to perfectly good wives and mothers by Dr. Kitty Ponse, professor of experimental zoology at the University of Geneva, and when she reported her results to the Second International Congress for Sex Research here, they created a considerable stir in biological circles.

The surgical removal of the sex glands of full-grown male toads was followed by the gradual enlargement of a tiny, hardly noticeable piece of tissue, called the organ of Bidder. This newly formed large organ upon closer examination turned out to be a female sex gland, an ovary, containing normal looking, mature eggs ready to be fertilized.

These ex-males mated willingly with real masculine toads and surprised scientists by their extreme partiality to their former sex in producing a progeny exclusively of males. Out of the 400 male-begotten and feminized male-conceived baby toads every single one turned out to be a male, presumably because of a peculiar organization of the eggs produced by the sexually changed animals.

In this connection it may be recalled that an American scientist, Dr. A. V. Domm of the University of Chicago accomplished another equally remarkable feat by changing the sex of birds into the exactly opposite direction. He removed in 175 young female chickens the left ovary, this being the fowls' only ovary; for the right one is always degenerated and atrophic. This small, degenerated nodule, however, very much like the organ of Bidder in toads, developed into a full-sized sex gland, but not to an ovary, as one might have supposed, but to the gland of the opposite sex, to a testicle. This newly formed male sex gland produced sperm, thus making the hens potential fathers.

Sex reversals caused by a loss of the sex gland occur also in nature. When male salamanders starve for many months their male sex gland occasionally degenerates completely, and upon finding food again they develop new sex glands in the place of the old, but the new glands are those of the opposite sex. And it happens that hens, too, lose their ovary, not by operation, but by disease. If tuberculosis should destroy their ovary, the effect is the same as after spaying; the small right nodule begins to grow and develops into a male sex gland.—*Science Service.*

STRANGE YELLOW CALLA LILY APPEARS IN PHILADELPHIA GARDEN.

A freak calla lily which may become a plant of floricultural value is reported by James Lambert, director of the botanic gardens of the University of Pennsylvania and formerly of Kew Gardens, London.

The plant, which appeared among the specimens of flowers in the experimental section of the garden, is a golden calla of the species *Zantedeschia elliottiana.* Unlike ordinary callas, however, it bears a leaf as well as a flower on its flowerstem, and the leaf is of the same bright color as the "spathe" or showy envelope of the inflorescence, which is itself slightly abnormal in shape and size. The rest of the foliage is of the usual green.

Pattern 171
or Direct Current

Pattern 172
for Alternating Current

Pattern 173
Single Phase and Direct Current Wattmeter

Pattern 174
VoltAmpWattmeter

Pattern 170
Portable Current Transformer

A Complete Line of
Jewell Master Instruments

Jewell Master Instruments are the first complete line of intermediate size instruments in bakelite cases of uniform dimensions. Practically every testing requirement is met by these instruments in connection with resistors and other accessories.

Knife-edge type pointers of seamless tubular aluminum; anti-parallax mirrors; large scale openings covered with non-shatterable glass; long hand drawn scales stepped and calibrated with a potentiometer or with standards of unquestioned accuracy, all combine to make reading accurate and easy.

The Jewell Master Line is practical equipment for the high school laboratory. Write for Bulletin 2012 which describes this complete line of intermediate size instruments.

Jewell Electrical Instrument Co., 1650 Walnut St., Chicago, Ill.

Manufacturers of a complete line of high grade A. C. and D. C. instruments, including switchboard instruments from 2" to 9" in diameter, and portable instruments from small pocket sizes to laboratory precision standards.

30 YEARS MAKING GOOD INSTRUMENTS

JEWELL

JEWELL

LABORATORY SUPPLY COMPANIES.

By JOHN M. MICHENER,
Wichita High School East, Wichita, Kan.

It is quite common to find a science teacher who buys chemicals and apparatus from only one or two laboratory supply companies and who does not know that there are many other firms in this business. These companies are scattered all over the country and all of them publish catalogs, some of them very complete and containing information of much value to the science teacher.

It would pay practically every science teacher to obtain copies of the catalogs of these companies because a study of their catalogs will give much information, and an increasing acquaintance with the many different kinds of apparatus which are illustrated and described therein. A list of the companies and their addresses is as follows:

Biological Supply Company, 1176 Mt. Hope Avenue, Rochester, N. Y.

Braun-Knecht-Heimann Company, 576 Mission Street, San Francisco, Calif.

Braun Corporation, 363 New High Street, Los Angeles, Calif.

Burrell Technical Supply Company, 1704 Fifth Avenue, Pittsburgh, Pa.

Cambridge Botanical Supply Company, 1 Lexington Street, Waverley, Mass.

Central Scientific Company, 460 East Ohio Street, Chicago, Ill.

Central Scientific Co., Eastern Division, 79 Amherst Street, Cambridge, Mass.

Chicago Apparatus Company, 1735 N. Ashland Avenue, Chicago, Ill.

Chemical Rubber Company, The, W. 112th Street and Locust Avenue, Cleveland, Ohio.

Cincinnati Scientific Company, 210 E. 2nd Street, Cincinnati, Ohio.

Claflin Company, George L., 70 South Main Street, Providence, R. I.

Daigger and Company, A., 159 W. Kinzie Street, Chicago, Ill.

Denver Fire Clay Company, 1742-1746 Champa Street, Denver, Colo.

Eberbach and Son Company, Ann Arbor, Mich.

Eimer and Amend, Third Avenue, 18th to 19th Streets, New York City, N. Y.

Empire Laboratory Supply Company, 507 W. 132nd Street, New York City, N. Y.

Fisher Scientific Company, 709 Forbes Street, Philadelphia, Pa.

Greiner Company, Emil, 55 Vandam Street, New York City, N. Y.

Heil Chemical Company, Henry, 212 S. Fourth Street, St. Louis, Mo.

Kauffman-Lattimer Company, 41 E. Chestnut Street, Columbus, Ohio.

Kny-Scheerer Corporation, 10 W. 25th Street, New York City, N. Y.

Laboratory Materials Company, 640 E. 71st Street, Chicago, Ill.

McKesson-Bedsole-Colvin-O'Dell, 1706 First Avenue, Birmingham, Ala.

Palo Company, 153 W. 23rd Street, New York City, N. Y.

Sargent and Company, E. H., 155 E. Superior Street, Chicago, Ill.
Schaar and Company, 556 W. Jackson Boulevard, Chicago, Ill.
Thomas Company, Arthur H., W. Washington Square, Philadelphia, Pa.
Universal Scientific Company, 11 E. Austin Avenue, Chicago, Ill.
University Apparatus Company, 2229 McGee Avenue, Berkeley, Calif.
Welch Scientific Company, W. M., 1516 Orleans Street, Chicago, Ill.
Wilkens-Anderson Company, 217 N. Desplaines Street, Chicago, Ill.
Will Corporation, 845 Merle Street, Rochester, N. Y.

SCIENCE QUESTIONS

Conducted by Franklin T. Jones, 10109 Wilbur Avenue, Cleveland, Ohio.

564. WHAT SHALL WE DO THIS YEAR?
Suggestions, please. Thanks! The Editor.

A Quick Answer with a Punch

A. C. Norris of McClure Community High School, McClure, Ill., answered the very day he received the October, 1930 number of SCHOOL SCIENCE AND MATHEMATICS. [I want also to know whether he read *all* the Journal *up to Science Questions* or whether he turned *to Science Questions first!*—ED.] *Here is Norris's letter in full.* Thanks, Mr. Norris, for the prompt and effective reply!—ED.

McCLURE COMMUNITY HIGH SCHOOL
Manual Training and Agriculture
A. C. NORRIS, Instructor

McClure, Ill , Oct. 6, 1930.

Mr. Franklin T. Jones,
Cleveland, Ohio.
Dear Mr. Jones:

Yes, Sir, give us sets two and three of Edison's list. What I would like to see is this:

Write to some leading man in his profession asking him to submit from 15 to 30 questions covering their field of activity along the line of Science, both physical and biological.

Dear Dentist: Give me 25 questions covering the field of dentistry.

Dear Criminal Lawyer: Submit 20 science questions you would ask a young man entering your office as apprentice.

Dear Blacksmith: A boy wishes to enter your shop; give me 20 questions he should be able to answer about iron, steel, fuels and related topics.

I think of plumbers, extensive fruit growers, cannery foremen, tannery foremen, candy manufacturers, pottery works, dyeing establishments, cotton mills, fertilizer works, meat packing establishments, newspaper offices as (a) reporters, (b) shop workers, (c) press room; electric power houses, foundries, steel mills, paper mills, the army, forest ranger, hospital training course and motherhood.

You asked me. I have answered. Thank you.

I am, very truly,

A. C. NORRIS.

PLEASE NOMINATE.

Mr. Norris has laid out a real program. Where and how get

hold of THE Dentist, THE Blacksmith, THE Printer, and all along the line to give us questions such as Norris asks for.

Mr. Reader, please nominate THE man in your community, who can do this for us. You see him and tell Conductor Jones. If you want Editor-Conductor Jones to do the writing, drop him a line and say so.

OTHER SUGGESTIONS WANTED.

Please give other suggestions as to work for the year 1930-1931.

---

565. EDISON'S QUESTIONS—PARTS II, III AND IV.

Teachers and Parent Teachers, please discuss Edison's Questions and send in answers.

EXAMINATION—EDISON SCHOLARSHIP AWARD.
West Orange, New Jersey, 31 July, 1930.
PART TWO.

1. If you owned the following items, set down the approximate price in dollars and cents for which you would sell them, and the sort of purchaser you would select:
   (a) Ford coupe which has run 5000 miles.
   (b) Basic patent which will reduce cost of manufacturing shoes twenty cents a pair.
   (c) Secret process of manufacturing a drug which will definitely cure cancer.
   (d) Ten acres of land in a good farming section of Iowa.
   (e) Trade information which will enable one competitive firm to take $1,000,000 worth of net profits a year away from another.
   (f) The secret of a new poison gas which will make any nation supreme in war.
   (g) Definite proof that the dishonesty of an employee is costing a multi-millionaire $200,000 a year.
2. When you look back on your life from your deathbed, by what facts will you determine whether you have succeeded or failed?
3. What qualifications do you think a man should have to be on the Board of Judges of the Edison Scholarship?
4. You are the head of an expedition which has come to grief in the desert. There is enough food and water left to enable three people to get to the nearest outpost of civilization. The rest must perish. Your companions are—
   1. A brilliant scientist 60 years old.
   2. Two half breed guides ages 58 and 32.
   3. The scientist's wife—interested mainly in society matters—age 39.
   4. Her little son, age 6.
   5. The girl you are engaged to marry.
   6. Your best friend, a young man of your own age who has shown great promise in the field of science.
   7. Yourself.

   Which would you choose to live and which to die? Give your reasons.
5. In the year 1900 how would you have gotten the first cable of a suspension bridge across an impassable gorge ½ mile wide?
6. If you could prescribe and enforce a system of education for the whole population of the world, on what essentials would you place the greatest emphasis?
7. If you had a brother who wanted to be an artist or a poet, would you encourage him or attempt to dissuade him? Why?
8. Assuming it were an engineering and financial possibility, and you were given the opportunity of devoting twenty years of

your life to be in sole charge of digging a hole 30 miles into the earth's interior, would you accept it or turn it down? Give your reasons.

9. Suppose your best friend came to you and admitted regretfully that he had deliberately wrecked your chances of winning the Edison Scholarship by writing a letter designed to hurt your standing with the Judges; what would you do?
10. Briefly state how you think Communistic propaganda should be dealt with.

PART THREE.

Answer the following letter:

OFFICE OF THE DEAN
XYZ University

Dear Mr. ——————— :

A visiting professor has made a study of Manchurian life and manners. He has volunteered to give three lectures on Manchurian cooking.

Before advising the professor whether or not the university would sponsor such a course of lectures, I desire to get the reaction of the student body. Please write me frankly.

JOHN ADAMS, Dean.

PART FOUR.

1. (a) Briefly identify the following: Jane Addams, Leonardo da Vinci, Charlemagne, John Ericsson, John Hay, Colonel T. H. Lawrence, Pasteur, Marco Polo, Phidias, Tamerlane.
   (b) Give the approximate dates of the following: Fall of Troy, Battle of Gettysburg, First successful aeroplane flight, Solomon, Birth of the earth, Michelangelo, Discovery of America by Europeans, Formation of the League of Nations, Pithecanthropus erectus, Norman conquest of England.
2. (a) Name the planets in the solar system.
   (b) What is a light year?
   (c) What causes the seasons of the year?
   (d) Name 4 anthropoid (man-like) apes.
   (e) What is the function of leucocytes?
   (f) What are chromosomes?
   (g) How is the bubonic plague transmitted?
3. (a) What did Lewis and Clarke do?
   (b) How many great civilizations can you name which flourished before the year one, A.D.?
   (c) What races have invaded the British Isles?
   (d) What was the Holy Roman Empire?
4. (a) In what countries are the following located? Taj Mahal, Johannesburg, Mandalay, Lake Titicaca, Monte Carlo, Oslo, Khyber Pass, Danzig.
   (b) What authors created the following characters? Tom Sawyer, Desdemona, Mulvaney, Dauber, Nicholas Nickleby, D'Artagnan.
   (c) Who were: Thor, Apollo, Tristram, Siegfried, Oberon, Robin Hood.
5. (a) From what source or sources are the following commodities derived: Aluminum, Ambergris, Asbestos, Bakolite, Brass, Chocolate, Felt, Glass, Rayon, Turpentine.
   (b) Name the five largest cities in the United States.
   (c) What connection has salt with the present revolutionary movement in India?
   (d) Who are: Joseph Stalin, Aristide Briand, Primo de Rivera.
   (e) What was the purpose of the recent international conference in London?

BOOK REVIEWS.

General Chemistry for Colleges, by B. Smith Hopkins, Professor of Inorganic Chemistry in the University of Illinois, Author "Chemistry of the Rarer Elements" and joint author "Exercises in Chemistry." 1st Edition. pp. x+757. 15x22x3.5 cm. Illustrated. Cloth. 1930. $3.72. Heath.

A brief study of this new college text gives the reviewer considerable respect for the manner in which it has been conceived and carried out. While there is little of novelty in the order of presentation there is great thoroughness in the presentation of the important principles of inorganic chemistry. Much cross referencing appears throughout the text and the student is well advised, in the preliminary "suggestions on how to study chemistry," to "learn to use the cross references." At the ends of the chapters there are more than the usual number of "exercises" for the author believes that "The ability to solve problems based upon a chemical principle is the surest evidence that the principle is clearly understood."

A rather close study of the section on "colloids" reveals a splendidly clear presentation of the essentials of the subject. The chapter on Atomic Theory, gas volumes, and molecular weights is finely taught using the chronological order in which the facts and theories actually came into use. The development of the modern ideas in regard to the structure of atoms is excellent, the facts in regard to vacuum tube discharge, radio activity, and X ray spectra being given first and then the probable explanation presented.

The discovery of element 61, Illinium, is modestly attributed by the author to "a group of American chemists."

While there are many applications of chemistry to industry and to daily life mentioned in the text it is primarily designed to give the student a "foundation" course in general inorganic chemistry. The earnest and capable student will find it a very helpful text. College teachers who are not fully satisfied with their present texts may well make a study of it. F. B. W.

Chemistry for Today, by William McPherson, and William Edwards Henderson, both Professors of Chemistry in the Ohio State University, and George Winegar Fowler, Head of the Science Department, Central High School, and Supervisor of Science, City Schools, Syracuse, New York. First Edtiion with the present group of authors. pp. xl+588. 14x20x2.7 cm. Illustrated. Cloth. 1930. Catalog price $1.80 subject to discount. Ginn & Co.

The introductory chapters and the pictures accompanying them all tend to make this new text attractive to the beginner in chemistry. The order of treatment of topics shows little of novelty-oxygen, hydrogen, water, composition of water, solutions, molecules and atoms, formulas, equations etc., indicate the usual standardized method of attack. A triple type of questions and problems following the chapters is however really novel—first we have a chapter summary in question form then a set of "Thought questions" and then an additional set of problems and suggested extra experiments "For Honor Students." Some excellent questions and problems are to be noted in these sections. The teaching of molecular weights is excellent. The experimental basis for atomic weights is omitted as too difficult for high school pupils to grasp. We wonder if the brighter pupils might not have gotten some comprehension of it if it had been as well presented as the matter of molecular weights. Similarly the experimental bases for subatomic structure end for Moseley's Law are omitted. The latter part of the text is devoted to descriptive chemistry of the metals; the middle part has excellent chapters on Colloids, on Petroleum, on Fuels and on Organic Compounds. High School Chemistry Teachers will want to see this text.

F. B. W.

A Laboratory Manual of Qualitative Analysis by Frederick W. Miller, Jr., Ph.D. Assistant Professor of Chemistry, New York University. 1st Edition. pp. xiii+233. 14x19.5x2.5 cm. Illustrated with some seven photographic illustrations of manipulations and with group charts. Cloth. 1930. The Century Co., New York.

A casual inspection of this new manual reveals that it is written in an understandable style. The reviewer is planning to try it on several high school pupils who have had first year chemistry and who want to do some more work while still in high school. Some experience with that class of students has shown that the usual college manual of qualitative analysis is a bit over their heads, and that the instructions are usually too brief for them. This manual seems to me above the average in the clarity of its instructions.

After a good section on "Laboratory technique" we have 25 pp. of "Preliminary" experiments intended to give the beginner some idea of the nature of the reactions and the character of the precipitates that he will be dealing with in the formal analytical work later on. Then comes the sequence of the five groups of metallic ions. The procedure for each group is followed by a series of brief but remarkably clear explanations of the reasons for the steps taken. Flow charts of each of the groups are also provided and these are ingeniously designed to make still clearer the procedure. Although we have many good manuals of qualitative analysis this new one should be examined by all who teach the subject. F. B. W.

New Frontiers of Physics by Paul R. Heyl, Physicist, U. S. Bureau of Standards. Cloth. Pages vii+170. 12.5x19 cm. 1930. D. Appleton and Company, 44 Hewes Street, Brooklyn, New York. Price $2.00.

The extremely rapid and marvelous development of physics has aroused the interest of people in all walks of life. Everyone wants to know the meaning of the startling pronouncements of the theorists, the significance of the products of experiment, the probable applications in industry and the effects on life and civilization. In the hope of answering some of the many questions in this field the publishers have presented this little book, written by a great physicist who has the ability to explain difficult concepts in simple language. It is not to be understood by this statement that the lay reader will find the answers to all his questions about time, gravitation, matter and energy, nor will even the reader trained in scientific thinking have all his riddles expounded, but each will find a clearer and more fascinating story of the revolutionary discoveries in modern physical science than has heretofore been presented in one small volume. In its field the book has no equal. It should be in every high school and college library. G. W. W.

Green Magic, The Story of the World of Plants by Julie Closson Kenly. Cloth. Pages xv+194. 13x18.5 cm. 1930. D. Appleton and Company, 35 West 32nd Street, New York. Price 92 cents.

This is an excellent science story book. It contains nineteen delightful stories of plant life told in language easily understood by children, but also interesting to those adults who are not so absorbed in society and finance that nature is no longer wonderful. How the mother plant puts up a lunch for each seed child before it starts on its long journey, how the trees unpack their clothes in the spring, fitting flowers to bugs, stamens that ride bee-back, seeds that are submarines, sailboats or airships, Nature's vacuum cleaners—the fungi: this is the way some of the most important botanical ideas are presented. Get this book for your little friend, boy or girl; put it in the school library and in the public library. Those that read it will know more botany than many a high school pupil with a semester credit in the subject. G. W. W.

Everyday Arithmetic for Printers by John E. Mansfield, Head of Department of Printing, Wentworth Institute, Boston. Second Edition Revised and Enlarged. Cloth. 131 pages. 13.5x20.5 cm. 1930. McGraw-Hill Book Company, 370 Seventh Avenue, New York. Price $1.50.

This text is designed for students who desire a knowledge of arithmetic applied to printing problems. The first four chapters deal with general arithmetic and the remainder of the book is devoted to technical applications of problems to the printing industry.

The author has attempted to provide problems that will meet the needs of Printers' apprentices. They are also adapted for Classroom work where arithmetic forms a part of the printing course. The book is attractive and should prove useful to teachers interested in printing.

C. A. Stone.

Arithmetic of Electricity, by T. O'Connor Sloane. 23rd Edition, pp. 230. 12x18.5 cm. 1930. The Norman W. Henley Publishing Co, New York. Price $1.50.

This book, while no doubt intended primarily for the use of the practical electrician, is also of value to any student who seeks an insight into the applications of the laws of electricity. In general the author states a law or rule and then proceeds to apply it in problems that are worked out in detail. Although formulae are stated for most of the rules, the working out of the examples is entirely by arithmetic, the author taking the stand that algebraic solution is beyond the scope of many workers in electricity. The arithmetical solution is in many cases longer than the algebraic solution would be, this being necessary because a short analysis of each problem must be made in order to give a complete understanding of each step in the solution.

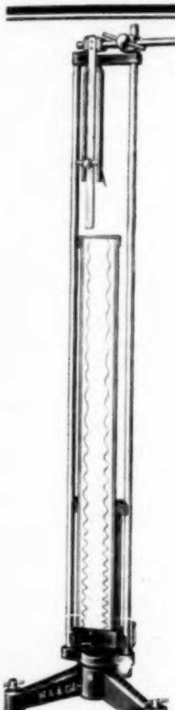
The first chapter is taken up entirely with definitions. The next fourteen chapters, which are logical divisions of the subject matter of electricity, cover nearly every type of problem in electricity which can be worked by arithmetical methods. In general the rules are not developed, the rules simply being stated and then illustrated with one or more problems. In one of the later chapters, however, some of the rules are demonstrated. A series of fifteen tables and some of the final chapters on units, notation in powers of ten, and networks add much to the value of the book for the practical electrician.

R. B. Stone.

Projective Pure Geometry by Thomas F. Holgate, Professor of Mathematics in Northwestern University. Cloth. Pages ix+286. 13x19.5 cm. 1930. The Macmillan Company, 60 Fifth Avenue, New York. Price $3.00.

Professor Holgate, whose translation of Reye's Geometrie der Lage many of us have studied with pleasure, now presents a work perhaps more usable as a textbook. The prosnective teacher of a course based upon this book will find an ample group of problems illustrating each chapter. Enough of them deal with plane figures to give good practise in drawing, and in making concrete the various concepts set forth. The student thus becomes familiar with the typical method of modern geometry, namely: projection and section, and finds justified the title: Projective Pure Geometry. The geometry is found to be pure in that only one numerical relationship is anywhere emphasized, the invariant of this type of transformation, known as the anharmonic or cross ratio. The Principle of Duality is one of the very beautiful features of this geometry, and one not found in geometries emphasizing metrical rather than positional relationships. This principle is brought to the attention of the student in Chapter Two, and, from there on, is emphasized by the printing in parallel columns of so-called dual or reciprocal propositions.

J. W. D.



Alternating Currents for Technical Students by Calvin C. Bishop, Head of the Department of Drafting and Design, Technical High School, Buffalo, New York. Cloth. Pages viii+317. 13.5x19.5 cm. 1930. D. Van Nostrand Company, Inc., 250 Fourth Avenue, New York.

This is a very excellent elementary textbook of alternating current theory and practice. The fundamental principles of A. C. circuits and apparatus are explained graphically and by means of many drawings and pictures, without resort to advanced mathematics. Because the book was written especially for technical and vocational students the practical phases of the subject are stressed. Many illustrative problems are solved and a sufficient number of practice exercises are included to insure thorough study of the theory. The last two chapters, the twelfth and thirteenth, are of the nature of appendices. A set of twenty-three selected laboratory experiments make up chapter XII. The thirteenth defines the fundamental trigonometric functions and illustrates their use in solving problems in vectors. The subject matter is well selected and the arrangement of topics is economically and pedagogically sound. The diagrams have been carefully made and are fully labeled but in a few cases the cuts have been so reduced in size that study is laborious. G. W. W.

Economic Geography by R. H. Whitbeck, Professor of Geography, University of Wisconsin and V. C. Finch, Professor of Geography, University of Wisconsin. Second Edition. Cloth. Pages x+565. 15x23 cm. 1930. McGraw-Hill Book Company, Inc., 370 Seventh Avenue, New York. Price $3.50.

This book needs no introduction to teachers of geography. It is a thorough revision of the first edition which appeared in 1924 and was written for students of college age. It is evident that the aim of the authors has been to emphasize the idea of man's adjustment to his environment; to show why a certain industry has developed in one place and a different one flourishes in some other section. But while stressing the influence of geographical features other factors such as social, historic and political influences have not been overlooked. It is this broad viewpoint and the rational plan of presentation that established the reputation of the former edition of this book and insures its continued popularity and success.

About half of the book is devoted to the study of the United States and Canada and the remainder to the other countries of the world. The extensive use of graphs, dot maps and halftones stimulates thoughtful reading. The references at the end of each chapter provide ample suggestions for supplementary reading.

G. W. W.

A General Science Workbook by Charles H. Lake, First Assistant Superintendent of Schools, Cleveland, Ohio, Louis E. Welton, Assistant Principal and Head of Science Department, John Hay High School, Cleveland, Ohio, and James C. Adell, Teacher of Science, John Hay High School, Cleveland, Ohio. Paper. Pages vi+346. 18.5x26 cm. 1930. Silver, Burdett and Company, 221 East Twentieth Street, Chicago, Illinois. Price $1.05.

This Workbook is composed of 16 units made up of 130 different problems. Most of the problems are composed of the usual laboratory exercises. Each unit contains explanatory and overview questions, experimental problems, questions for study, references for wording and study and words for spelling and use. Blank spaces are provided for the exercises and study lessons.

These lessons or problems have been tried out in the schools of Cleveland and found to be very successful. The problems are well selected and may be used without a text. The material is organized in such a way that it provides for individual differences. The book does not contain an index. I. C. D.

The Book of Knowledge Classroom Guide by Ellis G. Persing, Editor-in-Chief, School of Education, Cleveland. Cloth. Pages v+563. The Grolier Society, New York.

This Classroom Guide contains 500 lessons on the units of Geography, History, Biology, Poetry, Character Education, Art, Science, Health, Stories and Factual Reading. The lessons may be used in the elementary grades or the Junior and Senior High School. Each lesson states the Purpose, A Suggested Procedure, What to Look For, Questions, Pictures to Study and Other References. Most of the references may be found in the different volumes of the Book of Knowledge. The lessons make possible the practical application of a general reference set to classroom needs. I. C. D.

My Workbook in General Science by Ellis C. Persing, Department of Biology and General Science, School of Education of Western Reserve University and Kimber M. Persing, Department of Science, Glenville High School, Cleveland, Ohio. Paper. 128 pages. 21x27 cm. 1927. The Harter School Supply Company, 2046 East Seventy-first Street, Cleveland, Ohio.

This Workbook contains 16 units and 97 problems. These problems act as a self-directed guide for the pupil. General science textbooks may be used as reference materials. General references are also listed for each problem.

The problems are composed of laboratory and demonstrating exercises and study outlines. Blank spaces are provided for the answers. Each unit contains an introductory statement and each problem a brief explanation of its purpose. I. C. D.

Electricity for Beginners by Edward Harper Thomas, Author of "Forty Elementary Lessons in Electricity." Second Revised and Enlarged Edition with 28 original Drawings. Cloth. Pages xxiv+172+26. 10.5x17 cm. 1930. The Norman W. Henley Publishing Company, 2 West 45th Street, New York. Price $1.50.

This book is an outgrowth of the author's "Forty Elementary Lessons in Electricity" which were prepared for manual training classes in grade schools. It discusses briefly all the more elementary and fundamental ideas of electricity and includes lessons on some of the more advanced topics such as self-induction, transformation, multiphase currents, etc. It is evident that so small a volume cannot go very deep into any part of the subject and it cannot be expected that much will be learned by the average grade school boy by a mere reading of the book. But the essentials are given and the technical terms are explained. If it is supplemented by the explanations and demonstrations of a skillful teacher many of the mysteries of electricity will be cleared up and the pupil will learn to reason out the electrical problems of daily life instead of doing things by rote and thus avoid many blunders. The language of the book is in general very clear and the short chapters are commendable in a book of this sort. In a few cases, however, some alteration should be made to avoid ambiguity; e. g., the diagram of the dry cell is placed in the discussion of the storage cell; this poor arrangement together with a somewhat faulty discussion of the storage cell is sure to result in misunderstanding. This change and a few other minor corrections would have spared this very excellent book much of the criticism that falls on many new textbooks after one error is found.

G. W. W.

BOOKS RECEIVED.

Laboratory Manual of Physics by Clinton Maury Kilby, Professor of Physics in Randolph-Macon Woman's College, Lynchburg, Virginia. Cloth. Pages vi+129. 14x21.5 cm. 1930. D. Van Nostrand Company, Inc., 250 Fourth Avenue, New York. Price $1.75.

Science and The Scientific Mind by Leo E. Saidla, Assistant Professor of English, Polytechnic Institute of Brooklyn and Warren E. Gibbs, Instructor in English, Columbia University and Lecturer in English, Polytechnic Institute of Brooklyn, Evening Division. First Edition. Cloth. Pages xiv+506. 14x20.5 cm. 1930. McGraw-Hill Book Company, 370 Seventh Avenue, New York. Price $3.00.

New Practical Exercises in Rapid Calculation by Earle Powers, Formerly Head of Commercial Department Medford Massachusetts High School and Harold W. Loker. Paper. 120 exercises. 14.5x22 cm. 1930. Ginn and Company, 15 Ashburton Place, Boston. Price 96 cents.

A Laboratory Workbook to accompany Chemistry for Today by William McPherson and William Edwards Henderson, both Professors of Chemistry in the Ohio State University, and George Winegar Fowler, Head of the Science Department, Central High School and Supervisor of Science, City Schools, Syracuse, New York. Paper. Pages xii+315. 15x23.5 cm. 1930. Ginn and Company, 15 Ashburton Place, Boston. Price 76 cents.

The World About Us, A General Science by Wm. Dean Pulvermacher, Chairman General Science Department, Jamaica High School, New York City and Charles H. Vosburgh, Principal Jamaica High School, New York City. Cloth. Pages v+382. Illustrated. 12.5x18.5 cm. 1930. D. C. Heath and Company, 285 Columbus Avenue, Boston, Mass. Price $1.60.

Matter and Energy, An Introduction by Way of Chemistry and Physics to the Material Basis of Modern Civilization by Gerald Wendt, Formerly Dean and Oscar F. Smith, Assistant Dean, School of Chemistry and Physics, The Pennsylvania State College. First Edition. Volume I. 64 Illustrations. Cloth. Pages xiv+335. 13.5x19.5 cm. 1930. P. Blakiston's Son and Company, Inc., 1012 Walnut Street, Philadelphia, Penna. Price $1.50.

The Measurement of Man by J. Arthur Harris, one of the leading Biometrists of the World and late Head of the Department of Botany University of Minnesota, Clarence M. Jackson, Director of the Institute of Anatomy, University of Minnesota, Donald G. Paterson, Professor of Psychology, University of Minnesota and Richard E. Scammon, Professor of Anatomy, University of Minnesota. Cloth. Pages vii+215. 15x23 cm. 1930. The University of Minnesota Press, Minneapolis, Minnesota. Price $2.50.

Trigonometry by A. R. Crathorne and E. B. Lytle, University of Illinois. Cloth. Pages ix+199+xvi+95. 12.5x19.5 cm. 1930. Henry Holt and Company, One Park Avenue, New York.

Reactions and Symbols of Carbon Compounds, A Textbook of Organic Chemistry by T. Clinton Taylor, Associate Professor of Chemistry, Columbia University. Cloth. Pages x+704. 14x21.5 cm. 1930. The Century Company, 353 Fourth Avenue, New York. Price $4.00.

Accounting, Principles and Procedure by Walter J. Goggin, Certified Public Accountant Professor, Head of the Accounting Department, Boston University College of Business Administration and James V. Toner, Certified Public Accountant Professor of Accounting, Boston University College of Business Administration. Cloth. Pages viii+476. 14x21.5 cm. 1930. Houghton Mifflin Company, 2 Park Street, Boston, Mass. Price $3.50.

Laboratory Manual to accompany Accounting Principles and Procedure, Part I by Walter J. Goggin, Certified Public Accountant Professor, Head of the Accounting Department, Boston University Col-

Mathematical Introduction to Economics by Griffith C. Evans, Professor of Pure Mathematics, The Rice Institute, Houston, Texas. First Edition. Cloth. Pages xi + 177. 14.5 × 23 cm. 1930. McGraw-Hill Book Company, 370 Seventh Avenue, New York. Price $3.00

The Theory of the Potential by William Duncan MacMillan, Professor of Astronomy, The University of Chicago. First Edition. Cloth. Pages xiii+469. 14.5x23 cm. 1930. McGraw-Hill Book Company, Inc., 370 Seventh Avenue, New York. Price $5.00.

General Physics by Wm. S. Franklin, Professor of Physics in Rollins College and G. E. Grantham, Assistant Professor of Physics in Cornell University. Cloth. Pages xvi+705. 15x23 cm. 1930. Franklin and Charles, 510 Race Avenue, Lancaster, Pa. Price $4.00.

The High-School Science Library for 1929-1930 by Hanor A. Webb, Peabody College for Teachers, Nashville, Tennessee. Reprint from Peabody Journal of Education. 48 page descriptive book list of recent books. Distributed by the author. Price 10 cents.

Bacteriology for Students in General and Household Science by Estelle D. Buchanan, Recently Assistant Professory of Botany, Iowa State College and Robert Earle Buchanan, Professor of Bacteriology, Iowa State College and Bacteriologist of the Iowa Agricultural Experiment Station. Third Edition. Cloth. Pages xvi+532. 13x19.5 cm. 1930. The Macmillan Company, 60 Fifth Avenue, New York. Price $3.00.

lege of Business Administration and James V. Toner, Certified Public Accountant Professor of Accounting, Boston University College of Business Administration. Paper. 15 chapters. 22x28 cm. 1930. Houghton Mifflin Company, 2 Park Street, Boston, Mass. Price $1.80.

College Chemistry Quiz Book for Kendall's Smith's College Chemistry by Cecil V. King, Assistant Professor, Washington Square College, New York University and Worth Wade, Formerly Instructor, Washington Square College, New York University. Cloth. Pages viii+206. 13x20 cm. 1930. The Century Company, 353 Fourth Avenue, New York. Price $1.50.

A Second Course in Algebra, A Text and Exercise Book with Tables by Harry C. Barber, Head of the Department of Mathematics in the Phillips Exeter Academy, Exeter, N. H. Cloth. Pages xvii+505. 12.5x19 cm. 1930. Houghton Mifflin Company, 2 Park Street, Boston, Mass. Price $1.40.

Strayer-Upton Junior Mathematics, Book One by George Drayton Strayer, Professor of Education, Teachers College, Columbia University and Clifford Brewster Upton, Professor of Mathematics, Teachers College, Columbia University. Cloth. Pages vi+266+xix. 12.5x18 cm. 1929. American Book Company, 330 East 22nd Street, Chicago, Illinois.

Strayer-Upton Junior Mathematics, Book Two by George Drayton Strayer, Professor of Education, Teachers College, Columbia University and Clifford Brewster Upton, Professor of Mathematics, Teachers College, Columbia University. Cloth. Pages vi+282+xxii. 12.5x18 cm. 1929. American Book Company, 330 East 22nd Street, Chicago, Illinois.

Strayer-Upton Junior Mathematics, Modern Algebra, Ninth Year by Clifford Brewster Upton, Professor of Mathematics, Teachers College, Columbia University. Cloth. Pages vi+314+xxxii. 12.5x 18 cm. 1930. American Book Company, 330 East 22nd Street, Chicago, Ill. Price $1.20.

Lois Empiriques Par Des Formules Approchees, A L'Usage Des Chimistes, Des Physiciens Des Ingenieurs et des Statisticiens par M. Freghet, Professeur a la Faculte des Sciences de Paris et R. Romann, Professor a la Faculte des Sciences de Strasbourg. Librairie De L'Enseignement Technique, Leon Eyrolles, Editeur, 3 Rue Thenard, Paris.

The Type of High School Curriculum which Gives the Best Preparation for College. Published as a Bulletin of The Bureau of School Service. Volume II, Number I, University of Kentucky. 105 pages. 15x23 cm. 1929. For sale by Campus Book Store. Price 50 cents. Lexington, Kentucky.

Laboratory Manual of General Chemistry by Harry N. Holmes, Professor of Chemistry in Oberlin College. Third Edition. Cloth. Pages x+153. 14x21.5 cm. 1930. The Macmillan Company, 60 Fifth Avenue, New York.

Work-Test Book in Physics by A. W. Hurd, Institute of School Experimentation, Teachers College, Columbia University. Paper. xix Teaching Units. 148 pages. 20.5x28 cm. 1930. The Macmillan Company, 60 Fifth Avenue, New York. Price 64 cents.

Questions and Problems for Gordon's Introductory College Chemistry by Neil E. Gordon, Professor of Chemical Education, The John Hopkins University and E. G. Vanden Bosche, Assistant Professor of Chemistry, University of Maryland. Paper. 111 pages. 13x20.5 cm. Roebuck and Sons, Mulberry Street, Baltimore, Maryland. Price $1.50.

An Introduction to Mathematics with Applications to Science and Agriculture by Isaiah Leslie Miller, Professor of Mathematics, South Dakota State College of Agriculture and Mechanic Arts. Cloth. Pages xiii+297. 13x20.5 cm. 1930. F. S. Crofts and Company, 41 Union Square, West, New York. Price $3.00.

AIDS FOR BIRD STUDENTS.

Publications Relating to Birds, for Free Distribution by the United States Department of Agriculture.

Bird Migration. (Department Bulletin 185.)

Eleven Important Wild-duck Foods. (Department Bulletin 205.)

Propagation of Wild-duck Foods. (Department Bulletin 465.)

Lead Poisoning in Waterfowl. (Department Bulletin 793.)

Waterfowl and Their Food Plants in the Sandhill Region of Nebraska. (Department Bulletin 794.)

Food and Economic Relations of North American Grebes. (Department Bulletin 1196.)

Food Habits of Some Winter Bird Visitants. (Department Bulletin 1249.)

Food Habits of the Vireos. (Department Bulletin 1355.)

Food of American Phalaropes, Avocets, and Stilts. (Department Bulletin 1359.)

The Magpie in Relation to Agriculture. (Technical Bulletin 24.)

Our Migrant Shorebirds in Southern South America. (Technical Bulletin 26.)

Wild Birds Introduced or Transplanted in North America. (Technical Bulletin 61.)

The English Sparrow as a Pest. (Farmers' Bulletin 493.)

Some Common Games, Aquatic, and Rapacious Birds in Relation to Man. (Farmers' Bulletin 497.)

Food of Some Well-known Birds of Forest, Farm, and Garden. (Farmers' Bulletin 506.)

How to Attract Birds in Northeastern United States. (Farmers' Bulletin 621.)

Some Common Birds Useful to the Farmer. (Farmers' Bulletin 630.)

Common Birds of Southeastern United States in Relation to Agriculture. (Department Bulletin 755.)

How to Attract Birds in Northwestern United States. (Farmers' Bulletin 760.)

How to Attract Birds in the Middle Atlantic States. (Farmers' Bulletin 844.)

How to Attract Birds in the East Central States. (Farmers' Bulletin 912.)

The Crow in its Relation to Agriculture. (Farmers' Bulletin 1102.)

Community Bird Refuges. (Farmers' Bulletin 1239.)

Canaries: Their Care and Management. (Farmers' Bulletin 1327.)

Homes for Birds. (Farmers' Bulletin 1456.)

Propagation of Game Birds. (Farmers' Bulletin 1521.)

The Great Plains Waterfowl Breeding Grounds and Their Protection. (Yearbook Separate 723.)

Conserving Our Wild Animals and Birds. (Yearbook Separate 836.)

Farm Help from the Birds. (Yearbook Separate 843.)

Directory of Officials and Organizations Concerned With the Protection of Birds and Game. (Annual Publication.)

Local Names of Migratory Game Birds. (Miscellaneous Circular 13.)

Partial list of publications on birds for sale by the Superintendent of Documents, Government Printing Office, Washington, D. C.

(Send cash or money order, stamps not accepted.)

Distribution and Migration of North American Gulls and Their Allies. (Department Bulletin 292.) 15 cents.

The Purpose of Bird Censuses and How to Take Them. (Department Circular 261.) 5 cents.

Birds of the Papago Saguaro National Monument and the Neighboring Region, Arizona. (Bulletin U. S. National Park Service, 63 pages.) 10 cents.

Fifty Common Birds of Farm and Orchard. (Farmers' Bulletin 513, 31 pages, with colored illustrations.) 25 cents.

Wild Animals of Glacier National Park, Mammals and Birds. (Bulletin U. S. National Park Service, 210 pages.) 50 cents.

Biological Survey of Pribilof Islands, Alaska. 1. Birds and Mammals; 2. Insects, arachnids, and chilopods. (North American Fauna No. 46, 255 pages.) 40 cents.

Life Histories of North American Gulls and Terns. (U. S. National Museum Bulletin 113, 340 pages.) $1.25.

Life Histories of North American Wild Fowl, Order Anseres (Part). (U. S. National Museum Bulletin 130, 311 pages.) 90 cents.

Life Histories of North American Marsh Birds. (U. S. National Museum Bulletin 135, 385 pages.) $1.25.

Life Histories of North American Shore Birds (Part I). (U. S. National Museum Bulletin 142, 419 pages.) 85 cents.

Returns from Banded Birds (Technical Bulletin 32, 95 pages.) 20 cents.

(For addition titles write to Superintendent of Documents, Washington, D. C., for Price List 39, on Birds and Wild Animals. Sent free.)

Popular Books for the Identification of North American Birds

Bailey, F. M. Handbook of Birds of the Western United States. Cloth, or pocket edition bound in leather, $6. Houghton Mifflin & Co., Boston, Mass.

Chapman, F. M. Handbook of Birds of Eastern North America. Cloth, $4. D. Appleton & Co., New York City.

Coues, Elliott. Key to North American Birds, Ed. VI, 2 vols., $15. The Page Co., Boston, Mass.

Henshaw, H. W. The Book of Birds. $3. National Geographic Society, Washington, D. C.

Hoffman, R. A Guide to the Birds of New England and Eastern New York. Cloth, $3; pocket edition, flexible binding, $4. Houghton Mifflin & Co., Boston, Mass. Birds of the Pacific States. $5. Houghton Mifflin Co., Boston, Mass.

Reed, C. A. Bird Guide. (In two parts.) Part I. Water and Game Birds; Birds of Prey East of the Rockies. Part II. Land Birds East of the Rockies. Cloth, per part, $1.25; leather, per part, $1.50. Doubleday, Doran & Co., Garden City, N. Y.

Reed, C. K. Western Bird Guide. $1.75. Doubleday, Doran & Co., Garden City, N. Y.

Wyman, Luther E., and Elizabeth F. Burnell. Field Book of the Birds of the Southwestern United States. Cloth, $3.50; leather, $5. Houghton Mifflin & Co., Boston, Mass.